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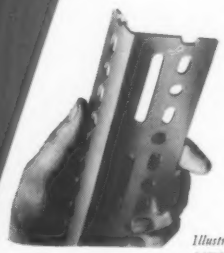

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Mechanical World —— January 1959

Mental Mechanism

IF it ever comes to be asked, which came first, the computor or the brain, the answer might well depend upon the accuracy of historical information kept in magnetic storage for the simple reason that if the rate of accumulation of factual knowledge continues to accelerate the volume will become so great as to be far beyond the storage capacity of the human brain. There might be reason for thinking, in fact, that this applies today when specialization often seems to be the only way in which so many people are able to contribute usefully to scientific and technological development. There is, of course, the alternative of using the human brain more efficiently. If it is true that the memory depends upon the retention of small charges in a mass of nerve centres, and that dissipation of a charge means that a memory, or part of one, is lost, also that memory can only extend in volume to the storage capacity for these charges, then there is obviously good reason for not occupying this storage capacity with chance impressions, aimless conversation, light literature, or in fact with anything but what it is desired shall be useful for a particular purpose. Life for such an end would have to be lived in a Shang-ri-la isolation, free from the miscellaneous impacts of city or industrial life. This might suit some people, but so little is really known on the subject, despite the complexity and ingenuity of the ideas and devices presented in the symposium on "The Mechanization of Thought Processes" held at the National Physical Laboratory, that it may not be necessary; it would be just as reasonable to expect in our present state of ignorance that at some future time a discipline will be discovered which will enable the brain to be tuned in as and when required—or rather the important part of it—using some smaller part over and over again to store and lose, store and lose information of a transient kind; a sort of frontal filter for testing information for its quality and usefulness before passing it on for permanent occupation. This seemingly fanciful speculation is illustrative of some of the processes described in the symposium. A machine is fed with axioms and then with data which it then proceeds to sort out, and the more it works the more it collects relationships, and the more these become conclusions and criteria for handling further data; thus it produces all the possibilities within the universe of which it has experience, and if it did that after reading the symposium the result would very likely include the notion of a discipline for the use of the brain. A curious thing about the work at present being done is that it is not on a line but more on a front. Thought processes and animal behaviour are lined up with computors of all kinds, from calculation to language translation and the control of surgery. Apparently the scientists who study the brain and the nerve system are getting quite a few ideas from the computor designers, and the vice-versa process has put the computor designers on the track of making machines that learn and think for themselves. It may be fortunate that the prospects—or the immediate ones—are of limited application due to the great bulk of the electronics apparatus required to do the work of only a small piece of brain; fortunate, that is, in that for general use such machines will only be time savers and not usurpers of human function. On the other hand the long term might see the machine do what no human brain could do. A vastly greater store, an unerring judgment, a capacity for taking every factor into account without neglecting even the smallest, and immune from the effects of weariness and the passage of time. Man sees a part of the light spectrum but knows of its real width and variety; he knows his limitations of hearing and touch and has devised instruments to extend his perception. He lives in what is to him his perceptible space but the phenomenon of time obviously excludes much that makes the pattern of the universe. The complete machine-brain might tell him what is beyond this veil, but it might have to instruct him in a good deal else before he could make head or tail of it.

LOG SHEET

Air Conditioned Assembly Area

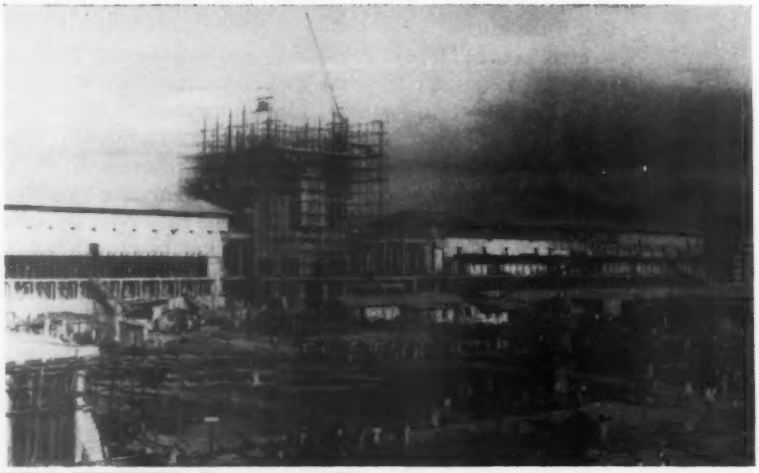
New air conditioned premises for the assembly and testing of precision gyro and optical instruments have been converted from a forty year old 'Northlight' timber truss building at the works of Kelvin & Hughes (Aviation) Limited, Barkingside, Essex. The area is divided into two distinct sections, flanked by a "goods in" and cleaning area, to which is confined all initial cleaning and machining operations. Critical work is carried out in pressurized cabinets in the largest room, which covers an area of 1665 sq ft and houses the gyro assembly and test equipment. This room is maintained at a slightly higher than atmospheric pressure and is the "ultra clean" area which controls the air and temperature conditions of the other rooms. Thermotank Limited were responsible for the air control installation which permits eleven air changes per hour in summer and five in winter. Room temperature in the gyro and sextant room is thermostatically maintained at 68°F.

A feature of the conversion is a development of a standard Anderson aluminium suspended ceiling where 0·010 in. translucent P.V.C. sheeting is stretched over 2 ft square lightweight timber frames. This is believed to be the first installation of its kind in Europe and it effectively solved the problem of installing a light-permeable ceiling which would not incur a weight penalty beyond the estimated safe maximum of 3·5 lb per sq ft which was capable of support from the old timber framework. The actual weight of the ceiling proved to be 2 lb per sq ft. Illumination is by six banks of 80-watt reflector type fluorescent tubes suspended above the ceiling on slotted angle support members. By this means, an overall room illumination intensity of approximately 40 lumens per sq ft is obtained.

Floors are covered in Crestaline P.V.C. sheeting supplied by Haskell Robertson Limited, and contain all the varied electrical and other services for the assembly and test benches which have been made for the purpose. All working surfaces are covered in laminated plastic and each bench contains a swivel tray for delicate components in addition to fitted drawers and a cupboard for small tools and overnight storage of partly assembled instruments.

All services to equipment are run in ducts, the covers of which are finished in the same floor covering. Gaps are kept to a minimum in order to avoid dust traps in the floor.

The assembly benches are grouped in five rows of two benches flanking the dust proof assembly cabinet; all finished work being passed to an inspection and test console, forward of the benches.



INDIAN STEELWORKS.—Progress goes according to schedule at Durgapur, West Bengal, where ISCON (Indian Steelworks Construction Company Limited), the British Consortium, is building a £100 million steel plant for the Government of India. This is a general view of the By-Products Plants under construction. In the background are coke oven batteries

All component parts are ultrasonically cleaned and dried in new, fully automatic equipment supplied by Electro-Chemical Engineering Company Limited, bearings being cleaned in a specially adapted spray cleaning booth.

Working surfaces are entirely cleared of equipment and instruments at the end of each working day to facilitate complete vacuum cleaning by Tellus equipment. Assembled instruments are stored in heated cupboards fitted with silica gel drying agents.

Entrance to the rooms is made via a cloakroom where the operators remove their outer clothing and shoes and enter the "clean" cloakroom where special protective clothing is put on, consisting of a siren suit type of overall made from Egyptian cotton, close fitting cap and leather soled Grecian type slippers.

Before entering either cloakroom and immediately before entering the "clean" area, each person has to pass over a "Taccy" mat which removes any trace of dust from the soles of the shoes. Morning and afternoon tea breaks are taken in the outer cloakroom, where smoking is permitted only at these times.

Ventilating Sinfin-C

The new Rolls Royce altitude test plant, Sinfin-C, consists of two test chambers each containing one high-altitude test cell in which the gas turbine engines for test are run. While under test there are no personnel in the cell, instrument readings and general control being exercised from a central control room. On completion of an engine test the cell is opened and large volumes of air are exhausted to clear away a possible accumulation of noxious gases. Ventilation and quick reheating of the cells for the engineers working on the dismantling and erection of the engines is a necessity if maximum utilization of the cells is to be ensured. To achieve this end, the Norris Warming Company Limited, Burley House, Theobald's Road, London, WC1, has installed a plenum plant consisting of a centrifugal fan drawing fresh air through a hair-type filter and steam heater battery before delivering the warm air to the working areas through multi-louvre adjustable grilles. As it was envisaged that work could be proceeding in both test chambers at one time or that either might be used separately, the fan is driven by means of a 2-speed

motor to operate on low speed when only one area is in use, or on high speed if both are in use. Isolating dampers were fitted in the branch ducts serving each area, so that the one not in use need not be unnecessarily heated.

The air heater battery is under thermostatic control, a valve on the steam main being controlled by a thermostat in the working space, the control being of the fully modulating type. Again, thermostatic control was designed to obtain control from either of the two test chambers, or with both in use, and a selector switch was provided to enable the appropriate control scheme to be brought into operation. The thermostatic control system is of the electronic type, the essential feature of thermostats in the working space being that they should be of a flameproof nature to avoid explosion risks.

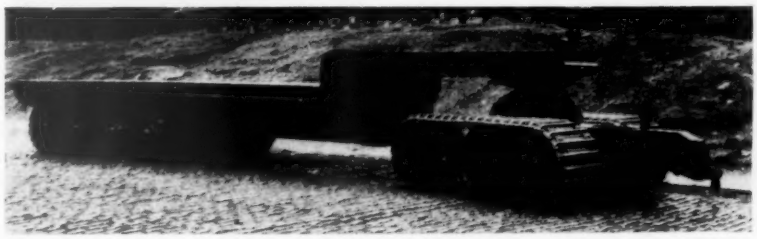
In addition to the foregoing, Norris Warming Company Limited also installed the heating and ventilating system in the exhauster station and input circuit buildings at the same site. The heating installations in each of these two buildings was designed to operate using saturated steam at up to 120 psig, with a normal pressure of 90 psig. For the warming of the buildings recirculating heaters on the floor and wall mounting type were used, each being provided with local isolating valves and steam traps of the thermostatic pattern. For the control of temperature in the buildings, room thermostats are provided, these stopping and starting the unit heater motors on the rise and fall of temperature over and above 60°F. Steam and condense pipework serving the various heaters is carried at high level in the buildings, welded joints being used throughout.

The buildings house electrical equipment of high output and when this is put into operation, all forms of direct heating have to be isolated, and to enable this to be effected quickly steam heaters are provided in each building with isolating valves on the connections run to the various sections. The whole of the steam and condense pipework has been insulated with rigid glass silk sections so as to reduce the emission of heat from pipework to a minimum.

The consulting engineers for both these installations were Messrs. McLellan and Partners in association with Messrs. Merz and McLellan.

Unusual Transport Equipment

Designed to transport heavy oilfield equipment over swamp land in the Niger Delta, a new type of trailer was shipped recently to the Shell-BP Petroleum Development Company of Nigeria Limited. Built by R A. Dyson & Co. Limited, of Liverpool, in conjunction with Shell engineers, the 28-ton trailer is fitted with especially wide rubber and steel tracks, instead of normal pneumatic tyres. These tracks give a very low ground pressure of between 8 and 9 psi fully laden, a remarkable figure, since the gross weight of the trailer is 44 tons. The 3 ft wide front and rear tracks are, respectively, 8 ft 9 in. and 12 ft 9 in. in length, and have been supplied by James A. Cuthbertson Limited, of Biggar, Scotland. The flat platform body measures 25 ft by 9 ft 3 in. A steel roller at the rear facilitates loading with skid-mounted oilfield drilling equipment, which is hauled on to the trailer by means of a winch rope from the tractor. The main frame of the trailer is in the form of a water-tight box girder 2 ft 9 in. wide running the full length of the load-carrying platform to act as a support in the event of the tracks sinking in extra soft ground. The forecarriage, which is of similar fully boxed construction, also forms the drawbar and is fitted with an S.A.E. 36 in. universal fifth wheel.



Tracked trailer (below) for use on swampy ground and (above) a steerable bogie, two items of special equipment for moving oil drilling machinery

A steerable bogie, the first of its kind to be made in the U.K., was also shipped recently to Venezuela. The bogie, of 20 tons capacity, will be used in conjunction with an oilfield truck to transport a 133 ft high drilling mast, weighing about 38 tons, as a complete unit. Developed by R. A. Dyson & Co. Limited in association with Shell engineers, it will help to reduce rigging-up time to a minimum. With mast loaded on truck and bogie, the outfit is approximately 145 ft long. In view of this, many adverse factors have had to be overcome in the design stages involving the elimination of bending loads and stresses of the mast whilst in transit.

Free-piston Gasifiers

The first application of free-piston gasifiers to pipeline pumping will be a 3000 hp unit on the Iraq Petroleum Company's pipeline in Syria. The contract, which also covers the design and supply of all auxiliary equipment, has been secured by National Free Piston Power Limited, a subsidiary of the Hawker Siddeley group.

The machinery will comprise four 1000 hp GS.34 free-piston gasifyers and one Series 300 expansion gas turbine manufactured by Brush Electrical Engineering Company Limited, of Loughborough, which will drive a Mather & Platt Plurovane pump. The free piston gasifyers will be able to run on the crude oil being pumped through the pipeline. The contract also covers the design and supply of all auxiliary equipment.

As further evidence of the growing acceptance of this type of equipment for oil pumping the Societe Industrielle Generale de Mecanique Appliquee (S.I.G.M.A.) French manufacturers of the GS34 free-piston gasifyer, have received two contracts from three French oil companies operating in the Sahara. These are for three 1500 kW free-piston turbo-alternator sets to supply power to the new tanker loading terminal at Bougie, Algeria

Noise-proof Phone

Speech has always been difficult in noisy workshops but it is almost impossible in the vicinity of jet engines. However, at the new Altitude Test Plant of Rolls Royce Limited, Derby, where some of the world's most powerful jet and turbo-prop engines are dealt with, telephone communication is a necessity and it has been extensively studied in collaboration with Communication Systems Limited, and as a result a special amplified speech system has been developed.

The site is divided into three sections, each of which has an associated control room where data is recorded, and three of these systems have been installed. By employing a special handset, consisting of padded earphones and larynx microphone, and a wall-mounted control box fitted with a volume control, instructions can be passed quickly and accurately between the control engineer and personnel responsible for making adjustments to engines under test.

Each system consists of a master station, situated in the control room, associated amplifiers, and up to 12 sub-stations. Because of the extremely high noise level, a flashing lamp is used to signal sub-stations that they are being called. Telephone communication can then be quickly established by the test-bed engineer through his special headset. As soon as the headset is plugged into the control panel, the signal lamp is switched off and it is only necessary to press a "speak" key. Amplified two-way conversation may then be carried on without either party operating a speak/listen key.

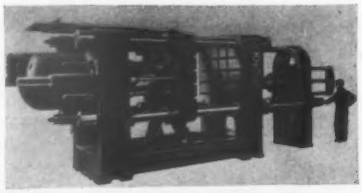
Signals from sub-station to control room, the latter being sound-proof, are made by buzzer in the normal way. Speech reproduction in the control room is through built-in loudspeakers. By using moving-coil transmitters and receivers, reception obtained is superior to normal telephone quality.

Flexible Foundations

A new factory of 16,000 square feet (1,500 square metres) is now being erected for Rocol, Limited, Swillington, near Leeds, England, the world's leading firm in the development and manufacture of specialized molybdenized and other lubricants for industry.

The progress of Rocol, Limited, during the past decade has been almost geometrical annually. Its 38 specialized lubricants are sold in every country in the free world, and the result of the ever increasing demand and the pressing needs of research and development expansion, is the new 16,000 sq ft factory on a seven-and-a-half acre site at Swillington, near Leeds.

The West Riding of Yorkshire, in which Swillington is situated, has one of Britain's richest coal seams. Unfortunately, worked out seams mean land subsidence and, because of workings under the Rocol site, it is expected that the land will subside about two feet during the next five years. This set a problem for the architects, Braithwaite & Jackman. Discussions were opened with the National Coal Board as to the best way in which to lay the foundations of the intended building. The result was a plan which is the first of its kind to be projected for a factory building in Britain.



BIGGEST DIE-CASTING PRESS.—The giant Triulzi M 25 press, believed to be the largest of its type in the U.K., which J. V. Murcott Limited, Birmingham, have acquired. It has a charge capacity of 40 lb and a clamping force of 1000 tons

The new building is divided into six separate sections linked together with watertight expansion joints. Each section will thus be able to move separately without serious fracture. The completely separate foundations of each section consist of a 6 in. thick concrete raft, laid in triangular portions on the subsoil excavated to one formation level, and a top raft of reinforced concrete 6 in. thick. The two layers of concrete are separated from each other by a layer of sand which will enable the floor to slide should, through subsidence, the bottom layer rot and fracture. The steel stanchions are anchored into concrete blocks protruding above the ground floor level and reinforced into the top slab.

If subsidence does occur it is expected that the general effect to the building will be similar to that of a railway engine passing over sleepers, which wave and recover immediately.

The superstructure is also being carefully planned to allow for movement. The timber window frames have deep rebates to minimize the splintering of glass and the drains have moveable joints and are reinforced on concrete rafts. The building is fire resisting and thoroughly heat insulated. The heating is by hot air to the factory portion and by electric overnight storage in the offices and laboratories. When the building is complete, the exterior walls will be in terra-cotta brick and where possible climbing plants will be encouraged to cover the walls.

When the estate was bought 200 trees were planted, flower beds laid out and some excellent lawns made. The building contractors are Messrs. Robert R. Roberts (Leeds) Limited.

New B.M.C. Plants

A major rearrangement of plant has been going on at the British Motor Corporation's factory at Durbar Avenue, Coventry, where some very large shops have been cleared to make room for five assembly lines and associated equipment transferred from the main factory at Courthouse Green and from the Austin works at Longbridge. The new plant will be given over entirely to the production of replacement engines and gearboxes for B.M.C. cars (including some models made more than 20 years ago) and will be the most modern and largest of its kind in the world. By next May it will be able to turn out 4000 engines per week. This centralization will release space at the other factories which will enable the production of engines and gearboxes for current models to be increased.

Another B.M.C. development is the new £3 million car painting plant at Cowley. It is 1400 ft long and contains more than seven miles of piping which supplies the almost totally automatic spray booths from 52 silver painted 100-gal churns in a central dispensary. Some 3000 gal of paint in 26 colours are used every week. The new plant has its own Roto-dip installation for rust-proofing complete car shells.

Beneath the factory floor are two 50,000 gal tanks, one to receive waste from the primer and sealer booths, the other from the finishing paint booths. The paint scum is scooped off the surface to be dumped later in a disused gravel pit, and the water is re-circulated. Trucks carrying bodies can do so at adjustable heights in order to cope with the varying shapes, without disturbing

the settings of the automatic sprays. The conveyors in the booths have been slatted so that booths can be cleared for cleaning and maintenance.

With one exception all the baking ovens are oil fired—the exception being the infra-red oven at the beginning of the line in order to expedite the speedier drying of the stopper process.

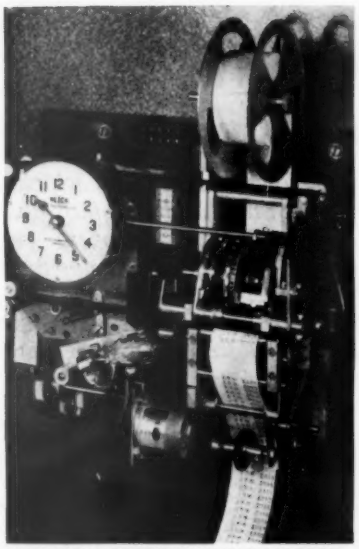
Production Engineering Dictionary

Many leading authorities in the field of production engineering research in many different countries attended the General Assembly of the International Institution for Production Engineering Research (C.I.R.P.), which was recently held in Britain for the first time. At the end of the assembly, Dr. D. F. Galloway, director of the Production Engineering Research Association of Great Britain, was elected vice-president of the institution for the ensuing year, and he will officiate in this capacity at the 9th General Assembly to be held in Switzerland in 1959.

The International Institution for Production Engineering Research was formed in 1949–50 when the four founder members decided to establish a common meeting ground on which scientists in the field of production technology could discuss their problems freely in an atmosphere of mutual trust and confidence. Production engineering research workers from 14 different countries now report their findings to the Institution, which thus plays an important role in the evolution of improved production techniques in many parts of the world. To ensure the highest standards of reporting and discussion, senior membership of the institution is restricted to not more than four leading authorities in the field of production engineering research in each country. The institution has for one of its main objectives the removal of barriers to effective communication between production engineering research workers in all parts of the world, and to this end is compiling an international dictionary of production engineering.

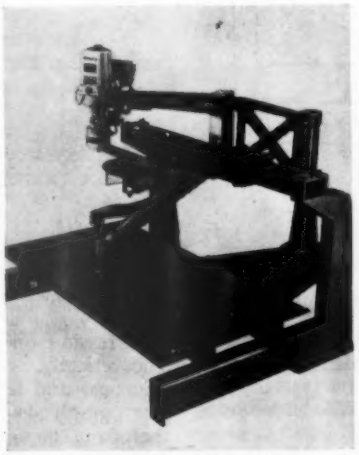
Versatile Profile Cutting

A recent survey reveals that in eighteen United Kingdom factories of the British Sugar Corporation there are no less than eleven oxygen profiling machines employed primarily for maintenance purposes, and the installation of further machines is under active consideration. Eight of the eleven machines are of the radial U-arm type shown in the accompanying photograph. This is the Hancomaster U-1 profiling machine manufactured by Hancock & Co. (Engineers) Limited, of Croydon.



AUTOMATIC PERFORMANCE RECORDER.—Initially developed for use in a manufacturing organization using a form of automation, this Blick recorder is electrically connected to an unmanned transfer machine to provide records which can be analysed and used towards increased efficiency and production. The instrument records the day, the time to the nearest minute, and the component serial number every time a component passes through the transfer machine, on a continuous paper roll which is passing through the recorder at a speed arranged to coincide with the operational performance. The time capacity of the roll is fourteen days, but if the controlling machine closes down at night, or ceases production for any other reason, either deliberate or accidental, the roll continues to pass through the recorder for three minutes and then stops, and restarts when the controlling machine recommences production. The recorder can be used as a semi-portable instrument or as a permanent fixture, or it can be operated by remote control at any distance so that a supervising engineer can have any number of instruments in his office

With a cutting area of 50 in. × 25 in. and the capacity for straight cuts of up to 7 ft 6 in. long and circles up to 36 in. dia in steel from $\frac{1}{8}$ in. to 8 in. thickness, the Hancomaster has proved itself equal to all routine maintenance demands. There are two larger machines in the range.



Hancomaster 0-1 profiling machine

A decisive factor in the acceptance of machines of this type by maintenance engineers is their ability to produce a single profiled part by hand tracing direct from a drawing. They can, of course, also operate from templates of steel, wood or aluminium strip for longer runs.

The increasing use of these machines in maintenance workshops reflects the conviction that they can rapidly justify their comparatively low capital cost in averting or minimizing major breakdowns of production and processing equipment.

Where highly mechanized production techniques prevail as in the sugar or coal industries the case for a profiling machine is clear cut, but many smaller organizations now employ compact profiling machines in the toolroom where even for intermittent work, they are considered well worth the small floor space occupied and the investment involved.

Round-the-world Telephone

Although radio communication is a later development than the submarine cable it has done nothing effective to displace it; in fact, the growing inter-continental telephone and telex traffic has shown the cable to be indispensable. The latest developments in submarine cable engineering have emphasized this position and the proposal for a round-the-world Commonwealth telephone cable is therefore soundly based both technically and economically. The project was considered at the Commonwealth Trade and Economic Conference in Montreal last year and it may well be that only the timing of the construction remains to be settled.

Safety Dividend

The British Safety Council estimates that the 5% reduction in the industrial accident rate last year saved British industry £12½ million. Last year's figures were the lowest for 20 years. The Council's aim is to achieve a 50% reduction in the next ten years.

Elastic Moduli

In the study of stresses in engineering structures, elastic moduli are usually considered and other moduli such as moduli of section and vibration are mentioned, all of which may be confusing especially when considered with moduli for liquids and gases which have become of ever increasing importance in recent years. Also, their relation to the different forms of stiffness is not always understood. Further, it is not generally realised that a thorough grasp of the fundamentals enables calculations to be considerably simplified. The following article gives the result of a thorough investigation

By W. H. SHEPPARD, B.Sc.(Eng.)

Modulus of elastic fibre (λ)

Consider an elastic fibre, length L.
Let load applied = F and consequent extension $\partial L = e$
If the fibre is perfectly elastic, $e \propto L$ as stated by Hooke's Law, i.e. extension is proportional to the applied load.

Then λ = load/strain

$$= \frac{F}{e/L} = \frac{F.L}{e} \text{ or } \frac{\partial F.L}{\partial L} \quad (\text{Note. } \partial F = F)$$

The load-extension graph is then a straight line as shown in *Fig.* 1 and $\lambda = \cot \theta$. This modulus will be termed the deflection modulus and must not be confused with material moduli which will be considered next.

Young's modulus (E)

It is well known by engineers that, considering an elastic material in tension and compression,

E = stress/strain
= F.L/A.e or $(\partial F/\partial L)(L/A)$
where A = area of cross section.

Comparing this with the previous case it will be realized that whereas E usually applies to very small deflections as met with in engineering structures, λ usually applies to relatively large deflections, but theoretically

$$\lambda = EA$$

and Stiffness $S = \lambda/L = EA/L$ (or $\frac{E}{L/A}$)

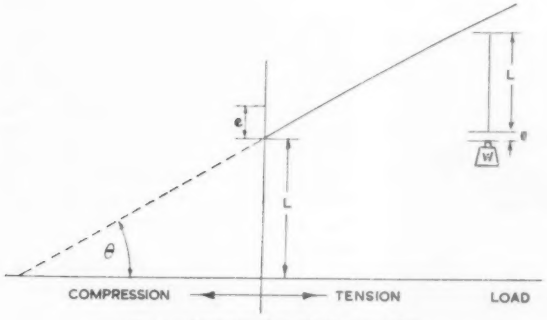


Fig. 1.—Extension of elastic fibre or spring

The realization that these different moduli exist and an understanding of the simple relationship between them should avoid confusion in practical applications.

Regarding actual measurement of E, engineers are familiar with tension and compression tests and as the area of cross section decreases and increases respectively, apparent stress is given by the quotient F/A, A being the original area of cross section. If length is plotted against load or apparent stress, a curve is given as shown in Fig. 2.

If the quotient F/A′ is used, A′ being the true area, a straight line graph is given. Fig. 2 shows both tension and compression on one graph for comparative purposes. Theoretically, compression could continue to zero thickness and tension until local extension took place. The graph is approximately hyperbolic, deviation therefrom being caused by change of cross sectional area. Figures 2 (*a*) and (*b*) show the usual methods of

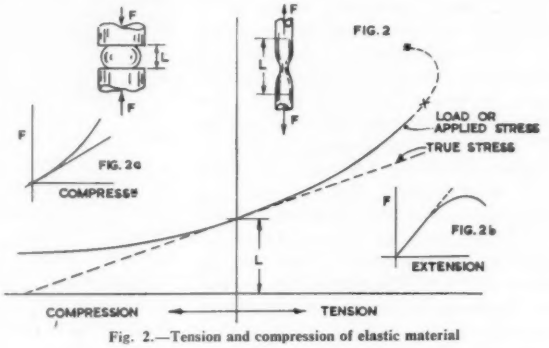


Fig. 2.—Tension and compression of elastic material

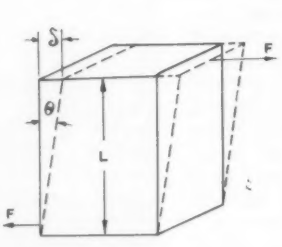


Fig. 3.—Shear strain

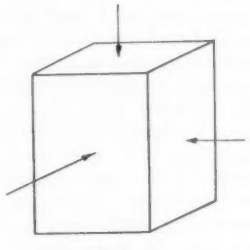


Fig. 4.—Volumetric strain

plotting, these being rare cases where the consequent variable is plotted horizontally.

Shear modulus (C)

Considering a material in shear as shown in Fig. 3

C = shear stress/shear strain

$$= \frac{F/A}{\partial/L} \text{ or } \frac{F/A}{\theta}$$

$$= (F/A)(1/\theta)$$

The analogy with Young's Modulus is apparent, the deformation being at right angles to the applied force as against in-line.

The commonest examples of shear stress are found in the rivets in boilers and structures, the members themselves being in tension or compression. It should be realized that members in tension or compression also undergo shear stress and members strong in shear are liable to fail at right angles to the load, whilst members strong in tension are liable to fail at 45° thereto.

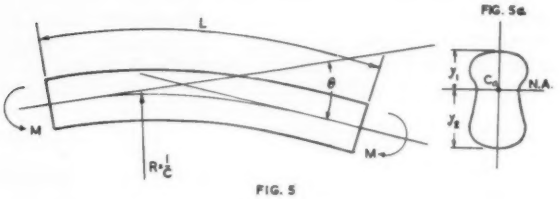


FIG. 5

Fig. 5.—Bend strain

In this case Shear modulus = CA

$$\text{Shear stiffness} = CA/L \text{ or } \frac{C}{L/A}$$

Bulk modulus (K)

If a material is subjected to a uniform stress in every direction, as in Fig. 4, its volume is reduced and although for most engineering calculations this is negligible it is of importance in theoretical calculations. The bulk modulus is given by

K = stress/volumetric strain

$= (F/A)(V/\partial V)$

$= (F/\partial V)(V/A)$

the analogy with tensile stress being apparent.

If a body is subjected to longitudinal strain, the lateral strain is given by

m = longitudinal strain/lateral strain

Where m = Poisson's ratio (3-4 for most metals). It is shown in text books on strength of materials that

$E = 2C(1+1/m)$

$E = 3K(1-2/m)$

$E = 9CK/(3K+C)$

Since K and C are independent of each other, they are theoretically fundamental: in practice E and C are so taken.

Bending of beams

Considering a uniform beam subjected to uniform bending as indicated in Fig. 5. In recognized text books it is shown that

(a) The neutral axis passes through the centre of area of cross section

(b) The well-known formula

$f/y = M/I = E/R$ is derived.

Here the analogy with tension and compression is apparent.

Tension and Compression. $f = W/A = Ee/L$ (or E.s).

Bending $$f = \frac{M}{I/y} = \frac{E.y}{R} \text{ (or E.s.y).}$$

In the latter case the applied load becomes the applied moment M, and A becomes I/y, termed the *modulus of section* Z. In practice the maximum tension and compression stresses are considered, the limiting values of $y(y_1$ and $y_2)$ giving the tension and compression section moduli.

With regard to bend stiffness

$S = M/\theta = M/cL = MR/L = EI/L$

where c = curvature or strain, R = rad. of curvature

$= 1/c$ and bend modulus $\lambda = SL = EI$

(This is often erroneously called bend stiffness)

The stress (f) is given by $f = M/Z$

In the case of non-uniform bending,

$\partial = M/QEI$

Q being a factor depending on the circumstances

whence $\partial/L^2 = WL/QEI$

$\partial = WL^3/QEI$

For cantilever.	$Q = 3$	Concentrated load.
For pinned beam.	$Q = 48$	
For encastré beam	$Q = 192$	
For cantilever.	$Q = 8$	Uniformly distributed load.
For pinned beam.	$Q = 384/5$	
For encastré beam.	$Q = 384$	

Stress is also given by $f = M/Z$ but varies along the beam.

Eccentric loading of beams

The following formula is well known for eccentric tension and compression

$$f = (F/A)+(My/I)$$

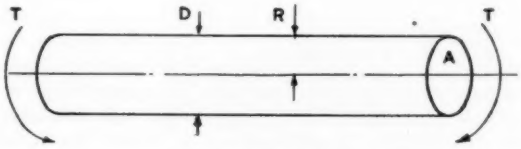


Fig. 6.—Torsional strain

This is better written as

$$f = F/A+M/Z$$

giving a logical derivation from tension/compression and bending.

Torsion in shafts

Consider a uniform shaft subject to a torque or moment at each end as shown in Fig. 6.

In recognized text books it is shown

$f = T/J = C\theta/L$

In this case analogy with shear strain becomes apparent

Shear $f = F/A = C\theta$ (or C.s)

Torsion $f = T/Z = C\theta.y/L$ (or C.s.y).

The applied load becomes the torque T and A becomes J/r, the polar modulus.

For skin stress as usually considered r = R or D/2

whence $Z = \pi R^4/2R = \pi R^3/2$ or $\pi D^3/16$

For hollow shafts $Z = (\pi/2)(R^3-r^3)$ or $(\pi/16)(D^3-d^3)$

Torsional stiffness is given by

$S = T/\theta = CJ/L$

and torsional modulus = CJ

Springs

Springs may be regarded as elastic fibres and dealt with accordingly. If the material shear stress is to be considered however, the formulae given in the last column of the final summary are used.

Spring stiffness (Load÷Deflection) is often called the modulus, which is misleading as it is liable to be confused with the modulus used for the spring material considered as a fibre.

Liquids

Liquids have only bulk modulus and only applied pressure is considered. In most liquids compression is negligible but special liquids are now used in liquid springs.

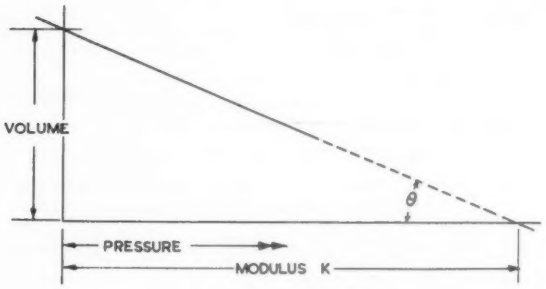


Fig. 7.—Volumetric strain of solid

$$K = \frac{\text{pressure}}{\partial V}.V.$$

$$= \frac{\partial P}{\partial V}.V$$

Hooke's Law is applicable and a straight line P.V. graph is used in Fig. 7. Here again the bulk modulus is the pressure theoretically required to reduce the volume to zero.

Gases

Unlike solids and liquids where there is no initial pressure, in dealing with gases both the initial and applied pressure must be considered. In previous cases

$\partial V = V$ and $\partial F = F$ (though $\partial L \neq L$).

Here again only bulk modulus is considered and the related pressure and volume. In this case the pressure and volume are related by a curve. (It is misleading to regard gases as "springs" and Hooke's Law does not apply).

$K = (\partial P/\partial V).V$

= Theoretical increase in pressure required to zero volume

= Theoretical decrease in pressure to double volume

both at initial slope of PV graph

It will be realized that the modulus changes as the volume and pressure change. In *isothermal expansion* PV = constant and the graph is a rectangular hyperbola. It is shown in co-ordinate geometry that a tangent is parallel to a diagonal of the rectangle formed by the co-ordinates;

whence K = P (pressure)

This fact is well known but there is no foundation for taking it as "obvious". Reference to Fig. 8 will show the implication.

Referring back to Fig. 3 it will be realized that the load/deflection (or apparent stress/strain graph) is similar to an isothermal for a gas.

Note:—Since E is generally adopted in engineering for Young's modulus, this has been used in the present article and K retained for bulk modulus and volumetric elasticity. In books on physics Y is used for Young's modulus and E for volumetric elasticity. With regard to units, engineers use lb/in^2 and physicists use dynes/cm^2.

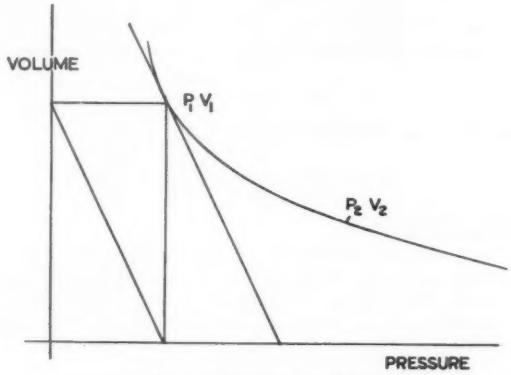


Fig. 8.—Volumetric strain of gas

Resilience (R)

Resilience for elastic fibre = Work done/Length = W.D/L

Resilience for all other cases = Work done/Volume = W.D/V

Elastic fibre and springs $R = \frac{1}{2} . F^2/\lambda$

Tension and compression $R = \frac{1}{2} . f^2/E$

Uniform bending $R = \frac{1}{2}(k/y)^2(f^2/E)$

Rectangular section $(k/y)^2 = \frac{1}{3}$ $R = (1/6)(f^2/E)$

Round section $(k/y)^2 = \frac{1}{4}$ $R = (1/8)(f^2/E)$

Shear $R = \frac{1}{2} . f^2/C$

Torsion $R = \frac{1}{2}(e/r)^2(f^2/C)$

Since $(e/r) = 1/r^2$, $R = \frac{1}{4}f^2/C$

This applies also to springs

Liquids $R = \frac{1}{2} . P^2/K$

Gases

$$\text{Work done} = \frac{P_2V_2-P_1V_1}{n-1} \qquad R = \frac{P_2r-P_1}{n-1}$$

Isothermal W.D. $= P_1V_1 \log_e r$ $R = P_1 \log_e r$

SUMMARY OF FORMULAE

	Fibre	Solid				Spring
	Tension	Tension Compression	Uniform Bending	Shear	Torsion (Round)	Tension Compression
Material modulus	—	E	—	C	—	C
Deflexion modulus	λ	EA	EI	CA	CJ	$LCd^4/8D^3N$
Stiffness S	λ/L	EA/L	EI/L	CA/L	CJ/L	$Cd^4/8D^3N$
Deflexion δ	FL/λ	FL/EA	ML/EJ	FL/CA	TL/CJ	$8WD^3N/Cd^4$
Stress from F	—	F/A	M/Z	F/A	T/Z	$8WD/\pi d^3$
Stress from δ	λe/L	Ee/L	Ey/R	Cθ	Cθ/L	$Ced/\pi D^2N$
Strain	F/λ	F/EA	M/EZ	F/CA	T/CZ	$8WD^3N/LCd^4$*
Resilience	½.F²/λ	½f²/E	½(k/y)²(f²/E)	½f²/C	½(e/r)²(f²/C)†	½f²/C

Section modulus	Z = I/y,	Polar modulus = J/r	
Rectangular beam	$I = bd^3/12$,	$Z = bd^2/6$,	$(k/y)^2 = \frac{1}{3}$
Round bar	$I = \pi D^4/32$,	$Z = \pi D^3/16$,	$(k/y)^2 = \frac{1}{4}$
	$J = \pi D^4/64$,	$Z = \pi D^3/32$,†	$(e/r)^2 = \frac{1}{2}$

* Shear Strain = $8WD/\pi cd^3$

Vibrations

The term modulus is also used in connection with simple harmonic motion and vibration but should not be confused with other applications as simple relationships exist as follows:

Vibration modulus (μ) = acceleration/displacement = (f/e) or a/θ

Then $\mu = S/m = \lambda/Lm$ or λ/LI

Whence $\omega = \sqrt{\mu} = \sqrt{\lambda/Lm}$ or $\sqrt{\lambda/LI}$

frequency $n = (1/2\pi)\sqrt{\mu} - (1/2\pi)\sqrt{\lambda/Lm}$, or $(1/2\pi)\sqrt{\lambda/LI}$

period $T = 2\pi/\sqrt{\mu} = 2\pi\sqrt{Lm/\lambda}$, or $2\pi\sqrt{LI/\lambda}$

Length of equivalent simple pendulum (l) is given by g/μ

Whence $\omega = \sqrt{g/l}$, $n = (1/2\pi)\sqrt{g/l}$, $T = 2\pi\sqrt{l/g}$

Summary

It is necessary to understand clearly the difference between "deflection modulus" and "material modulus" and also the relation between modulus and stiffness. E and C are regarded as the fundamental material moduli for tension and shear respectively and the deflexion moduli (λ) are given by multiplying by A, I or J as appropriate. Stiffness S is given by dividing λ by the length. Deflections are given by dividing F, M or T by S, and stresses by dividing F, M or T by A or Z as appropriate. Thus if the fundamentals for tension are understood, others are easily deduced by analogy. Vibration modulus is given S/m or S/I and thence $\omega = \sqrt{\mu}$. Regarding the formulae, the fundamentals of tension and shear are reviewed in the text and the following formulae used:—

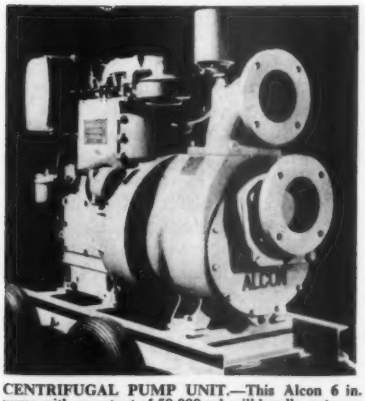
Bending $f/y = M/I = E/R$
Torsion $f/r = T/J = C\theta/L$

For comparative purposes, all formulae are listed as follows:—

Elastic fibre or spring $W = \lambda e/L$, (or λs, where s = strain)

Tension or compression	$f = W/A = Ee/L$, (or E.s)
Bending	$f = M/Z = E.y/R$, (or Es.y)
Shear	$f = W/A = C.\theta$, (or C.s)
Torsion	$f = T/Z = C.\theta.r/L$, (or C.s.r)

The accompanying table gives the values appropriate to tension and shear. Those appropriate to bulk moduli are given in the text.

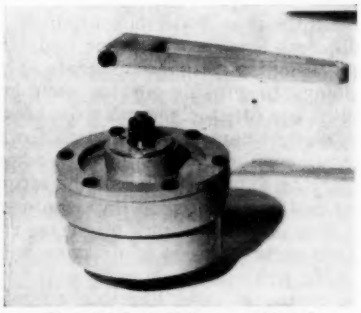


CENTRIFUGAL PUMP UNIT.—This Alcon 6 in. pump with an output of 50,000 gph will handle water up to 100°C and containing solids up to ¾ in. dia. Powered by an Armstrong Siddeley twin-cylinder air-cooled diesel developing 20 bhp at 1500 rpm, the unit consists of a centrifugal self priming pump, spigot mounted direct on to the flywheel housing. The makers are Arthur Lyon & Company (Engineers) Limited, 6 Carlos Place, Grosvenor Square, London, W1.

Dashpot for Servo-mechanisms

A precision-made dashpot for damping vibrations, or cushioning and halting linear or rotary motion in servo-mechanisms and in research apparatus has been developed by Kinetrol Limited, Trading Estate, Farnham, Surrey.

Movement applied to the dashpot lever causes two vanes attached to the spindle to rotate inside a cylinder filled with silicone fluid. A similar pair of vanes attached to the inner wall of the cylinder provide a restricted flow passage for the fluid. The design of the gaps through which the fluid must flow, and the viscous nature of the silicone fluid ensure laminar flow, so that the resisting torque is proportional to the angular velocity of the applied movement.



Kinetrol dashpot with lever arm detached

The damping rate varies from 50 to 2,000 lb in./radian/sec, the maximum safe torque is 250 lb in. and the standard cylindrical size 2·5 in. dia and 2·4 in. high, weighs 0·5 lb.

Some Uses of Interchangeable Die Inserts

Methods of reducing initial die costs when a series of designs show variations only in minor details

By HIRAM K. BARTON

FROM the earliest days of the diecasting industry attempts have been made to reduce the costs of tooling-up, for die costs have always been a much more substantial factor in piece-part costs than is the case in most metal-working processes. This is particularly marked when components are produced in relatively short runs, and various methods of reducing tool costs have been developed. Among the most successful has been the operation of the several different types of "nest" and "unit" dies, many of which have been described in this journal. By their nature, all these methods have been best suited to the production of relatively small diecastings; tools for components in the medium- and large-size diecastings; tools for components in the medium- and large-size ranges have almost always had to be constructed along conventional lines.

In one class of work, however, it has always been possible to reduce initial tool charges appreciably; this is almost always practicable when a set of diecast parts, identical in form except for some minor details, is called for. In such cases it has frequently proved economical to construct a single die possessing a main cavity containing the invariable portion of the casting contours, together with a set of interchangeable inserts which can be used in turn to produce the variable details. As a rule, each tool contains a pair of opposed inserts, but it is sometimes necessary to fit two or three distinct pairs of inserts in a single die.

The simplest application of interchangeable inserts is the use of "stop blocks". These are used to stop off a portion of a cavity and so produce a component shorter than that previously cast in the unmodified die. An example is a rod-bracket which is required in two different lengths, the shape and size of the ring being the same in both components. This is a very simple change to provide for; as seen in Fig. 1, cylindrical plugs are fitted in the main die block and the cavity for the longer component is partly formed within these. By removing these plugs and replacing them with others carrying the two halves of the terminal ring cavity, the far end of the original impression is isolated. Although a little metal may spew into these cavities when a heavy flash occurs, this is of no consequence.

The writer is occasionally asked whether it would not be better, in cases like this, to provide a loose spacer running right across the cavity insert. This would be put in place to cast the longer component, but would be removed, and the end part of the insert moved sideways to close the gap, when the shorter diecasting was required. Actually, such a course would not be practicable in this specific instance owing to the taper of the cavity, but the possibility has been canvassed in many different circumstances. For the most part, it has turned out that this would be a more expensive and elaborate procedure than the use of small stop blocks as in Fig. 1, largely because of the difficulties arising out of re-locating the ejectors bearing, respectively, upon the loose strip and the end portion.

Nevertheless, there have been instances in which this alternative has proved very successful indeed, and this for the reason that the greater part of the cavity detail was in the end portions and very little at the centre. An example that comes particularly to mind is a rather elaborate machine base which, a year or two before the war, was required in three distinct widths.

Apart from this dimensional variation, the details of all three sizes were virtually identical. It was arranged that some small variations not really affecting the

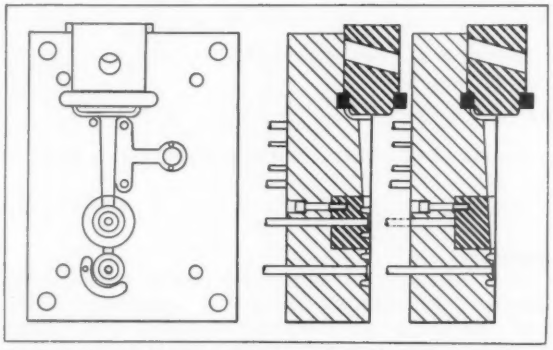


Fig. 1.—By interchanging the cylindrical plugs, short or long bracket castings can be produced from the same die

production technique, the particulars of which I do not now clearly recall, should be dealt with in a secondary machining operation.

The tool is shown, considerably simplified, in Fig. 2, where it is set up for the shortest frame. Both of the main die members are of built-up construction, consisting of a heavy back-plate to which are attached guide-blocks at top and bottom, and thrust-blocks at each end. Each member thus forms a chase or bolster into which the cavity elements proper may be locked. The cavity inserts are held in place by cap screws passing through the back-plate, the clearance holes for these being large enough to allow some lateral freedom.

To assure a good joint where the cavity inserts butt upon one another, the thrust-blocks carry large-diameter jack-bolts which can be tightened up to press the cavity elements together and which, additionally, provide fine adjustment of the lateral positioning of the opposed inserts. Vertical registration is accomplished by dowels and bushes in the guide-blocks. The sprue and main runner are located in the lower, wider, guide-block, and a parallel feeding-runner is cut in the cavity inserts.

Short channels crossing the joint connect the two, and it will be noted that the feeding-runner has alternative channels suited to the three different extensions of the cavity.

To produce components of either of the two larger sizes, one of two spacing-blocks is inserted between the cavity elements proper. For this, the tool has to be completely dismantled, the ejector gear removed and

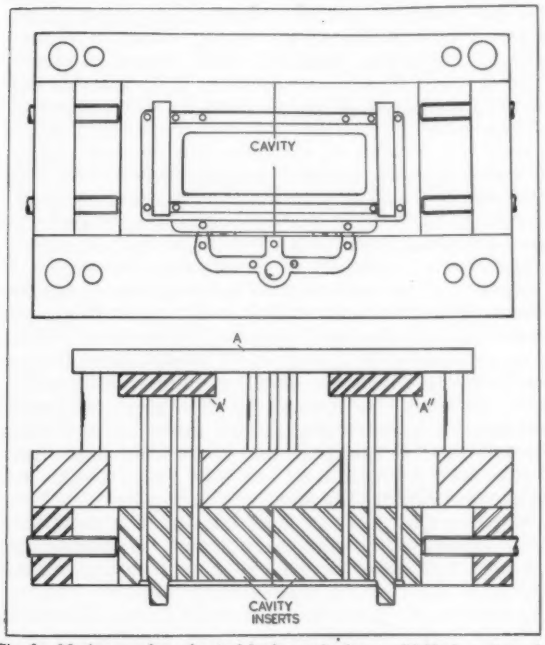


Fig. 2.—Moving member of a tool having cavity inserts slidable in a chase; by inserting a spacer between them the overall length of the diecast component is increased

the cavity inserts re-positioned. The back-plate provides three distinct sets of clearance holes for the cap screws which retain the cavity inserts, the tapped holes in the spacing-blocks being arranged to make use of the inner holes in the backing-plate. The spacing-block for the intermediate size bears only short lengths of cavity top and bottom, and a connecting length of feeding runner, but the large spacing block has an additional channel connecting the feeding runner with the main runner.

The tool is provided with a stout ejector-plate *A* (Fig. 2), but this carries only the ejectors bearing upon the main runner system. Each cavity half has a separate ejector array, these being mounted in secondary ejector-plates *A'*, *A''*. Plate *A* is provided with return pins in the usual manner, the secondary plates are bolted to *A* and can move only in unison with it. As with the cavity inserts, provision is made for the secondary plates to be secured in three different positions upon the main plate. No ejectors bear upon either of the cavity portions in the spacing-blocks, so there is no need of intermediate ejector arrays.

Although this tool is of rather more elaborate construction than a single tool for any one of the three sizes of frame, there is very much less work in it than in a set of three independent tools. The main disadvantage of dies such as this, in which some pieces are moved, as well as others withdrawn or inserted, is that all the loose pieces require careful cleaning prior to re-assembly in order to assure that they will bed down satisfactorily. However good a fit the joints are, lubricant and fine lamellar metal debris nevertheless penetrates them and becomes hardened. All these residues must be removed before a new, well-fitting joint can be established. This problem does not arise to anything like the same extent when changing from one component pattern to another which merely entails pressing out one insert of simple profile and inserting another.

Operationally, the most satisfactory method of using interchangeable inserts is to incorporate them in moving cores, for the substitution of one for another can then be carried out almost without stopping the machine. A good example of this (though calling for the simultaneous changing of two cores) is seen in the die section

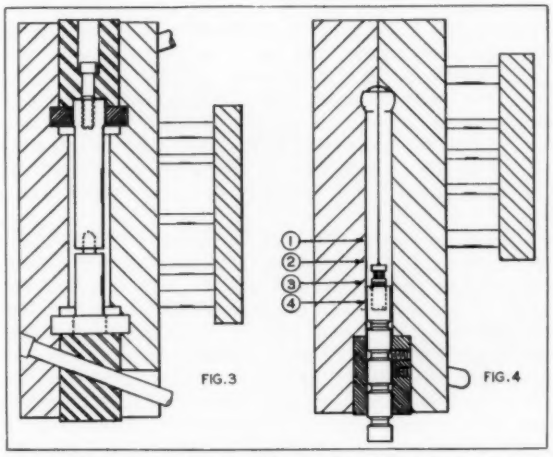


Fig. 3.—Pairs of cores are interchanged to alter the position of the gap forming the diaphragm of the component. Fig. 4.—In this simple casting, the overall length of the diecast portion is altered by changing the position of the insert holder in the sliding block

of Fig. 3. This tool produces a component that consists, essentially, of a tube with two flanged ends and a perforated internal diaphragm of variable position. The tool has only a single cavity and is provided with opposed core-slides each actuated by a pair of light finger-cams. The ends of the cavity—that is, the major part of the flange faces—are formed by stripper plates through which pass the working ends of the retractable cores.

These latter are paired, one of each pair having a spigot which forms the hole in the partition and is extended to enter a pilot hole in the end of the other. This assures a satisfactory degree of concentricity and brings off the flash around the small hole parallel to the core axis. It can thus be cleaned up with a de-burring tool instead of having to be punched out. The thickness of the partition is, of course, determined by the correctness with which the cores bed down in their housings at the end of the closure stroke, and in order that this may be held within close limits, provision is made for the protrusion of the cores from the sliding blocks to be adjustable so that wear on the mechanical parts can be compensated.

Although there are several sets of interchangeable cores, the tool is provided with only two pairs of sliding blocks. When a changeover is required, the requisite cores are mounted in the spare pair of blocks and are set for position by the use of a slotted tube of exactly the same length as the casting plus the thickness of the two stripper plates. This enables the position and

separation of the core ends to be checked before inserting the blocks. The sliding blocks themselves are retained only by spring detents, and can readily be removed from the tool.

The cores proper are held in place within the blocks by a single axial cap-screw and a lateral grub-screw (not illustrated in Fig. 3) which prevents any tendency to unscrew. Shims are placed between the head of the core and its seating, and these can be added to or removed at changeover. As soon as a pair of cores is removed from the tool, it is dismantled and cleaned so that the blocks are ready for the next interchange. The lift of the finger-cams is equal at both ends of the tool, and is in excess of the stroke of the longest core of the set.

Sometimes a much simpler tool than this suffices, as for example when it is desired to produce a component such as the handle of Fig. 4. Since the external diameter is substantially constant, it is only necessary (assuming that the component can be disposed symmetrically about the die parting) to provide a single sliding core-block fitted with a core that is adjustable within it to the various protrusions required. The core-stroke does not vary, of course, whatever the actual position of the core end, as in the tool illustrated, the withdrawal distance is always that needed to bring the core clear of the insert tip.

The adjustment of the core in this tool is extremely simple; the core shank passes right through the sliding block, between the finger-cam holes, and has circumferential V-grooves at intervals conforming to the differences in component lengths. A bevel-ended grub-screw enters the groove and locates it axially, whilst a cup-ended set-screw is tightened against the adjoining land, which is relieved some 0·010 in. so that the burr does not impede core adjustment. Since the overall length is not highly critical, this method is perfectly adequate.

It is sometimes worthwhile to consider sinking the whole of a cavity in an interchangeable insert, though only under rather specific conditions. These are: that the casting shall be relatively small and the wall thickness not highly critical, and that the details of the inner surface formed by the ejector die or core member shall be identical for all the components in the proposed set. These conditions are met, for example, by sets of knobs bearing diverse engraved detail on the outer faces, but identical so far as the undersides are concerned. Often the cavities are of a form suited to hobbing, and for the most part the method here described is appropriate only for multi-cavity tools.

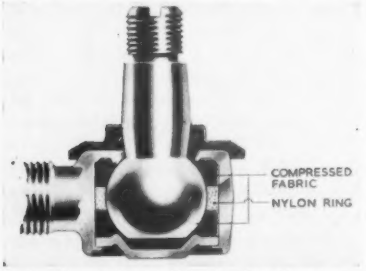
Tools of this sort are, indeed, halfway to a "nest" die, and have many of the advantages of the latter if construction is kept rigorously simple. Thus, in a four-cavity die with interchangeable cavity inserts producing a set of three distinct components, it is desirable that the full complement of inserts—four for each component pattern—shall be initially provided. If the cavities are hobbed this presents no difficulty. It is, however, not at all necessary that the tool should operate with four identical cavities at all times; if there are running orders for all the patterns it may be more advantageous to operate two and two, or even two and one and one.

Among the many circumstances that can render it possible to reduce tool costs by utilizing interchangeable inserts there is one that is often overlooked. This is the production of "handed" pairs of diecastings. Quite often, of course, it is well worth while constructing a two-cavity die to cast the pair, but in marginal applications, or where the demand has not been adequately assessed, the possibility of cutting down initial tooling charges may be attractive. It is not always practicable to produce paired parts in this way, but the scope for doing so is very readily seen.

Many handed pairs, in fact, differ only in some very minor detail; there is often opportunity to produce the opposite hand to a component merely by transposing inserts in the two die members, or even by rotating opposed inserts in the two halves of the tool through 180° without actually removing them. However, it is in practice much simpler, even when one or other of these two possibilities are open, to produce a separate pair of inserts for each hand. The blending of the cavities at the joint is so much less critical that the benchwork saved is likely to more than pay for the extra machining.

Nylon Bearings for Steering Joints

The properties of nylon—resistance to abrasion, good high load bearing qualities and stability have now been applied to the construction of automobile steering rod joints by Automotive Products Company Limited, Leamington Spa, Warwickshire. The Autolube steering joint comprises a full spherical ball pin supported in a bearing, the two ends of which consist of a compressed fabric impregnated with a patented dry lubricant, while the middle is a nylon ring. The assembly is arranged so that normal loads are carried on the fabric which provides a smooth resilient bearing; for heavier loads the fabric compresses still further and allows the load to be taken on the nylon ring. The patented dry lubricant is the result of considerable development, through which it is claimed the life of the bearing has been increased over eight times since its original introduction.



Section through the Autolube self-lubricating steering joint. Greasing of these joints is claimed to be completely eliminated

Reduction in the difference between the static friction and the dynamic or moving friction feature is very desirable in steering mechanisms, as it lessens the initial "start" effort when turning the steering wheel and enables steering to move smoothly from a position of rest. With the Autolube steering joint the actual dynamic friction can be varied on assembly within limits, without materially affecting the static friction, and this feature can be usefully employed to provide a controlled measure of damping between the road wheels and the steering wheel.

LIGHT WEIGHT BARREL SKID.—This aluminium alloy barrel skid made by Powell & Company, Burry Port, Carms, South Wales, is only half the weight of steel skids of equivalent length and capacity. The runners have replaceable wood battens positioned along the top of the metal section and the skid is fitted with steel hooks. Available in three standard lengths of 8, 10, and 12 ft, the skids are ideal for loading and unloading drums, barrels, etc.

Water Tube Boiler Explosions Since 1945

Explosions can happen even in carefully-operated boiler houses. This article summarizes the causes of the twelve water-tube boiler explosions in this country which have been investigated since 1945 *under the Boiler Explosions Acts*

By SYDNEY D. SCORER, A.M.I.Mech.E.

SINCE 1945 only twelve of the many water-tube boilers in service in the United Kingdom and in British ships have been the subjects of Reports of Preliminary Inquiry made by the authorities under the Boiler Explosions Acts. In these twelve explosions six people were killed and nineteen were injured. Although these totals are small, most of the explosions happened to ordinary boilers worked in ordinary circumstances, and their causes warrant examination.

Two of the explosions were due to low water. What happens to a water-tube boiler which has insufficient water depends on its type. If it is of sectional-header design the upper tubes are bared first and one or more may overheat locally. When the water level is very much lowered, several rows may be affected, and there may be a tendency for tubes to pull out of their headers.

In boilers of the multi-drum type where the tubes are inclined to the vertical, the upper ends of the tubes overheat first. If the brickwork setting exposes the under side of the plain part of the front steam and water drum to the fire, the drum may bulge. Generally, however, the tubes tend to bulge at their upper ends, the expansions are loosened, and, in bad conditions one or more may pull out of the drum.

When a mild-steel tube is overheated in service the behaviour of the metal conforms to a simple pattern of events. As the temperature increases the ultimate strength first increases and then decreases. Simultaneously, the yield point falls with increase in temperature and eventually reaches a point where the stress in the tube wall due to internal pressure is greater than the resisting power of the material. The tube begins to swell until the circumference of the bulged portion is between one and two times the original circumference. At that stage the tube wall may be so thin that rupture occurs, with a result similar to that depicted in Fig. 1.

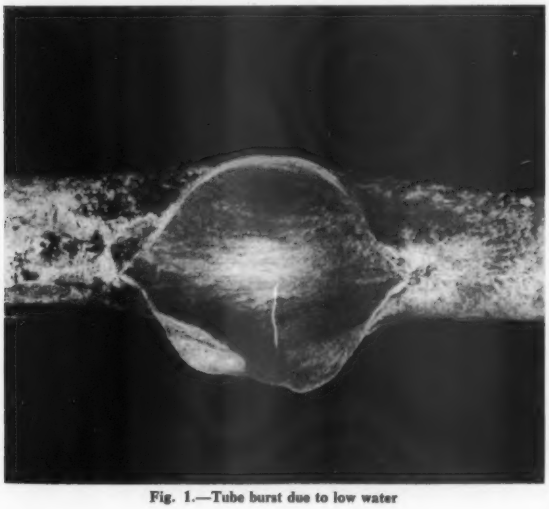


Fig. 1.—Tube burst due to low water

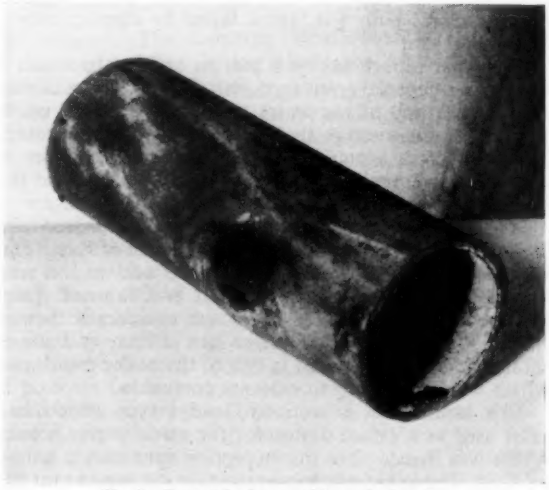


Fig. 2.—Fractured tube caused by scale deposits

One of the exploded boilers was a sectional-header type working in a power station. The practice there was to bank certain boilers ready for peak loads. Each had a non-return steam stop valve which automatically closed when the boiler went off load and its pressure dropped. When a boiler was needed again, steam was raised to line pressure and the stop valve automatically opened. Just before this happened it was the duty of the appropriate boiler-house operator to open the feed check valve and let the feed regulator take over. On the occasion in question the feed check valve was not opened, and one of a number of overheated tubes burst.

The other low-water explosion was in a multi-drum type, and was a culmination of two mishaps. In the first the feed pump failed, and during the time it took to get it going again the boiler was probably working with low water. Signs of damage were not apparent to the operators, but twelve hours later two tubes pulled out of the front steam and water drum.

Two of the reports are concerned with explosions due to internal scale deposits. When scale accumulates on the water side of a water tube overheating results, as already described, but the kind of failure varies. With thin but fairly heat-resisting scale the tube may bulge locally and

even fail, as in low-water conditions. But sometimes when the deposit is heavy the concentric layers of scale, while not preventing overheating, appear to relieve the tube of some of the internal pressure load. Consequently, instead of a comparatively lengthy tear, the metal merely bulges slightly and opens at the crest of the bulge, as illustrated in Fig. 2.

Usually failures due to internal scale follow from improper feed-water conditions, and in one of the boilers no special treatment had been given for the first 17 of its 24-year life. A number of tubes had acquired moderate deposits of a hard scale. Various tubes had been renewed in the past as they showed signs of bulging but those fitted during the seven years prior to the explosion had little or nor deposit on their internal surfaces. Unfortunately, one of the old tubes with deposits ranging from $\frac{1}{16}$ to $\frac{1}{8}$ in. thick failed by ripping over a length of $7\frac{1}{2}$ in.

The other report was on a marine boiler into which it had been necessary to feed salt water for make-up purposes. Many of the water tubes had deposits up to $\frac{1}{4}$ in. thick; the average thickness being $\frac{1}{8}$ in. There were also heavy soot accumulations on the outer surfaces of the tubes. Eventually one tube failed and discharged the contents of the boiler into the stokehold.

When external corrosion develops in a water-tube boiler it usually results from a combination of damp and soot deposits. The water dissolves the acid in the soot and the adjacent metal is attacked and thinned. Even when every care is taken there are sometimes narrow spaces where soot and moisture can collect, and something of the sort happened in one of the boiler explosions which were attributed to external corrosion.

This boiler was a sectional-header type which had been used as a refuse destructor for many years. A tube which was inaccessible for inspection split over a length of 12 in. The subsequent investigation suggested that the working conditions had been conducive to tube-end leakages and to condensation on the outside of the tubes. Any moisture thus deposited would tend to run to the front ends of the tubes and this water, in conjunction with soot deposits, would cause corrosion of the metal.

A similar state of affairs developed in another boiler when leakage from a defective superheater drain pipe dripped on to water tubes. The superheater was located over several rows of inclined tubes and the condensate ran down one tube until it was trapped by soot deposits at a brick baffle on the tubes. Here corrosion must have been fairly rapid and the tube finally burst over a length of $7\frac{1}{2}$ in.

In the third explosion, soot deposits and moisture were the major factors but certain periods of idle boiler time also contributed to the result. The failed tube was inaccessible for external inspection and was, in fact, one of a number recommended for early renewal on account of age. Corrosion of a tube took place under an area covered by a baffle, assisted by an accumulation of soot in the narrow space and the absorption of atmospheric moisture during idle periods. The wastage spread over a length of 11 in. until the tube wall was too thin to carry the internal pressure.

External erosion of tubes is a defect which has assumed some prominence in recent years as soot blowers have been more widely used. When first installed, soot blowers are arranged to remove soot accumulations between the tubes without the steam jets impinging on the surfaces. In time, jets may wear and their supports may go out of alignment, and then high-velocity sprays of steam and abrasive material scour the tube metal. The resultant thinning action can be rapid, and is very difficult to detect without skilled and close inspection. It is not surprising, therefore, that four of the twelve reports deal with soot-blower erosion explosions.

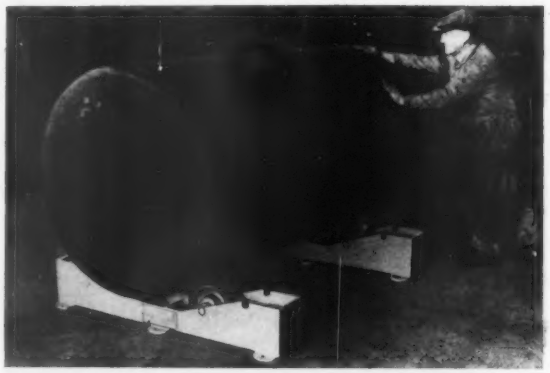
In one of the damaged boilers a soot blower pipe was provided with steam nozzles pitched to blow between the first row of tubes. Two adjacent nozzles were found to have become detached from the pipe, leaving holes $\frac{11}{16}$ in. dia. As a result of the greatly-increased discharge area the steam impinged on the next row of tubes and eroded two of them. It was one of these tubes which failed.

In another explosion the soot blower was a type in which a fan-shaped jet of steam was directed over the tube surfaces. Eventually one of the tubes in the bottom row became thinned more than the others, and a hole 4 in. long by $2\frac{3}{4}$ in. wide was made in it.

The other two explosions were similar in that the tubes which failed were in the second or third rows from the front. It is possible that the mass effect of the steam and soot mixture was at its maximum at that distance from the nozzles. In one of the instances there was no visual indication of the erosion, and it could be detected only by careful measurement.

The final report concerns a six-drum power-station boiler which was completely disrupted when the wrapper plate of the middle steam and water drum ruptured through the outer row of rivet holes for nearly the whole length of the front longitudinal seam.

The authorities made their own very thorough investigation of the history of the boiler, and where necessary called in experts such as those at the National Physical Laboratory, independent steel makers, etc., to arrive at the probable cause of the failure. After a review of all the evidence it was decided that the failure was due to caustic cracking of the drum metal. Small cracks had initially developed at the peripheries of rivet holes, and they had finally merged to form a line of weakened plate. This eventually failed under pressure.



Idler for Welding Cylinders

A low priced addition to the range of welding positioning equipment made by Courtburn Positioners Limited of Kempston Hardwick, Bedford, is the illustrated idler cylinder rotator. This particular model, type LC 50A accommodates cylindrical vessels from 1 ft to 7 ft 6 in. dia, with only two different roller settings. Rubber-tyred rollers complete with shafts and bearings are simply lifted from one pair of slots and placed in the alternative slots. Type LC 50B have longer frames with three roller settings to accommodate vessels up to 13 ft 6 in. dia. Each LC 50 idler section takes a load of $2\frac{1}{2}$ ton.

The Overhaul of a Back-pressure Turbine

Details of procedure are given with notes on points requiring particular attention. The recording of certain dimensions is recommended and suggestions are offered for getting the most information out of the trial run

By Wm. LAMB, M.I.Mar.E., M.Inst.F.

ADVANTAGE usually is taken of the annual holiday period, when production has ceased, to overhaul the power plant and boilers. This particularly applies in factories producing their own power, generated as steam and electricity. Strict attention to detail during overhaul and careful adjustment should enable a steam turbine to operate without failure from one yearly survey to another.

In preparation for this work, essential parts for replacement are ordered in advance. It is not unusual to find some unforeseen weakness and it will be necessary to arrange with the manufacturers for immediate replacement. It is common practice for the work to be supervised and carried out in the presence of the maker's engineer and thus facilitate speedy replacement. Any future renewals are noted and ordered without delay.

For purpose of illustration we shall discuss the overhaul of a 525 kW turbo-generator, operating at 6000 rpm with reduction gearing to drive a 425 V alternator. The turbine has two velocity wheels on the main driving shaft and is governed by a fluid link governing system. The steam flow is controlled by this system and enters through the emergency control valve, thence to the governing valve, to a steam chest, passes through fixed nozzles, impinges the velocity wheels, then goes to exhaust.

The fluid link governing system incorporates a stable centrifugal governor controlling the pressures under the throttle valve oil piston. Initial pressure direct from the boilers is 210 psi superheated to 560° to 580°F. The exhaust pressure is 40 psi at 440° to 460°F superheated.

In the governor casting is a piston, balanced above by a strong spring and below by oil pressure. The controlling valve is attached to the piston by a spindle, hence any alteration in pressure causes the spring to become compressed or released. When the oil pressure is increased, the steam control valve opens further; the opposite effect occurs on pressure decrease. Oil pressure is supplied by a helical pump driven from the turbine shaft. Attached to this pump is a vertical spindle at the upper end of which is fitted the main centrifugal governor. The governor moves a sleeve between its open and closed position for the full range required, and in the closed position the oil pressure available for governing is the full pressure in the turbine system, causing the throttle valve to be opened to maximum extent, in consequence of

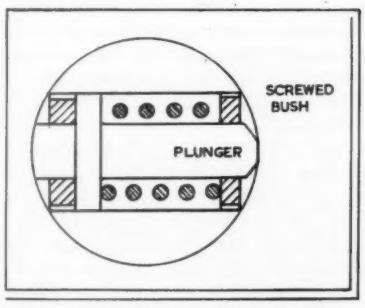


Fig. 1.—Emergency trig gear plunger and spring

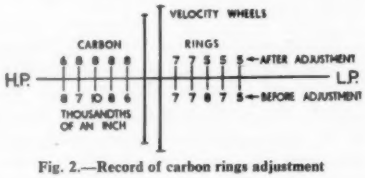


Fig. 2.—Record of carbon rings adjustment

which the turbine accepts the total load. When the governor moves the sleeve to the fully-open position, the oil pressure under the piston is zero and the throttle valve is closed by the spring above the piston.

The governor takes up a stable position for each load, and there is a fixed oil pressure under the piston for each particular load, depending on the characteristic of the spring above the piston. This is decided by the designed percentage speed variation—this can be discerned from the following table of pressures and speeds.

Oil relay pressure	Oil bearings pressure	Speed (on governor)
psi	psi	rpm
30	17	3500
33	20	4000
40	24.5	5000
42	27	5500
42	27	5700
36	23	6000

The governor commences to lift between 4500 rpm and 5700 rpm in this instance, and prepares to close around 5700 to 6000 rpm which is the operational speed. To prevent overspeed or underspeed an adjustment can be made by means of a trip out plunger.

It is important when overhauling the governing system to give each part attention to the extent that easy operation is secured whether it is cold or heated, and this applies particularly to the throttle or governing valve. Over a period this valve may develop creep in the metal due to the superheat. There is a tendency to stiffness in the valve which can be temporarily overcome by releasing the valve spindle and turning it to and fro using a spanner on the locking nut. When possible it is better to dismantle the valve and clean both the valve and the seating. It will be found that a gyrating movement of the valve causes wear on the side of the seating; this is due to a rubbing action from the wings of the valve caused in time by creep of the valve metal.

To disconnect the oil pot, in which is encased the piston, spring and spindle, the spring, normally held down by the casing cover, is released with the aid of two long set screws, and these are similarly used when replacing the spring in compression. The valve spindle is in two parts, the upper part being taken out with the piston, leaving the lower part easy of access after removal of the casing.

The combined emergency control valve is likewise dismantled and reground. Later, by unscrewing the cover nuts the whole of the governing gear, sleeve and springs, also the vertical shafts and the helical pump, can be lifted out and examined, also the trip gear.

This trip gear (Fig. 1) is used to close the emergency stop valve, thus preventing steam from entering the turbine if the oil pressure fails or if the turbine overspeeds. If the speed increases 10% beyond normal, a slight movement of the plunger closes the valve. During each yearly examination the position of the plunger should be noted. This plunger is encased in and revolves with the main shaft. The centre of gravity is marked on the plunger by the makers and is centralized by means of screw bushes which are secured to prevent slackening. If the plunger moves from the correct setting the turbine will trip at either underspeed or overspeed. To correct any error in this respect and to ascertain the correct position if not marked, it is essential to raise steam in the boilers so that the turbine can be operated up to normal speed and the machine tested for tripping at the appropriate overspeed.

While the governor and its gear are apart, the rotor and casing can be examined with advantage. As the whole shaft is exposed and free to revolve without attachments, it can be tested for wear and distortion by using a dial micrometer or bridge gauge for the bearings.

Trestles should have been prepared for accepting the rotor shaft when lifted out of the bearings. Examination is then possible of the velocity wheels, bearings and carbon rings, also the coupling to which is attached the alternator shaft and rotor. Points to note are any indication of blade erosion, undue wear of carbon rings, and wear on bearing scrapers which prevent oil creep along the shaft.

Carbon rings can be taken apart. They are constructed in three segments and have scarf joints to obviate leakage. The segments are held together by a garter spring of a special steel. Before taking the rings apart it is advisable to test the clearance of each by using feelers. A record can then be maintained yearly of the wear taking place (Fig.2). This operation also assists in discovering the amount of clearance essential to prevent steam leakage past the rings.

Due to the higher working temperature the high-pressure gland rings expand more than the lower pressure rings. Undue tightness on the shaft is liable to cause fracture of the rings. Hence, as in the accompanying diagram, in this instance slightly greater clearance has been allowed on the high-pressure side.

Removing the casing of the reduction gearing permits examinations of the gear teeth. If there is any wear it may be necessary to dress the upper halves of the teeth.

To clear the lubricating oil and enable the sump to be cleaned out, the oil is run into still drums where it is allowed twenty-four hours or longer to settle. A sample of oil is taken to test the viscosity and flash point. The oil cooler tubes are brushed. When the cooler has been re-assembled the oil is replaced or replenished as necessary.

When all the tubine parts have been cleaned, renewed as found necessary, and prepared for reassembly, including the rotor blades, the main shaft and rotor are replaced in the bearings. To protect the metal of the rotor it can be painted with a preservative (such as "Apexior").

When the machine is assembled, it is first turned by a hand lever to ascertain whether through oversight any part is tight or fouled. If all is clear then the governors may be raised with the hand wheel to lift the valve and admit steam to the rotor. The overload valve is slightly opened in case water settled while the turbine is warming through.

Before starting this type of turbine a hand pump is used to raise pressure in the oil system. To run up to speed, the main steam control valve is at first opened slightly until the machine is moving slowly. The exhaust passes to atmosphere when starting. More and more steam is admitted until, when the speed reaches 4500 to 5700 rpm, the governor commences to lift. The control valve can then be opened full and the governor will come into action at 6000 rpm if the speed control device is correctly set.

To test for overspeed, the governor handwheel controlling the piston spring valve is screwed upwards, thus increasing the opening of the governor valve. This is done slowly to find the exact speed above 6000 rpm at which the machine trips, as indicated by the tachometer. The trip gear should operate the emergency control valve at 10% overload, i.e., 6600 rpm. The valve then closes and the machine is stopped.

Before the turbine is ready to take the factory load it is essential that the machine be tested for back-pressure operation. It is run up to speed while exhausting to atmosphere and the atmospheric control valve is used to throttle the exhaust steam until the back-pressure steam gauge indicates 40 psi and while the steam control valve to the works remains closed. Then a slight movement of the turbine atmospheric valve, either opening or closing, will cause the governor to open or close at a mean pressure around 40 psi, thus showing correct operation. The turbine exhaust can now be changed over from atmosphere to the works steam main and the alternator connected to the switchboard and the electrical load applied.

The turbine has been found to be in order with no load, but this is not a sufficient test, so the reaction of the governor to loading is observed as the steam mains throughout the factory becomes heated by the exhaust steam, and various motors are started to put a load on the alternator. These are switched on and off to test the governor. The turbine remains operating for two hours to discover if there is any overheating of parts or leakage from joints. If all is satisfactory after this period the turbine can be closed down until required for service.

It is during overhaul periods that data on operating costs can be obtained concerning plant such as steam heaters for space heating, traps discharging condensate, office heating appliances and steam pipings. The steam used by these non-productive items can be obtained from readings of the steam, water and kilowatt-hour meters while the productive plant is shut down. The readings are taken before and after the two-hour test period.

Cast Iron Research and Development

Where the search for ductility is leading

GASES in steel have been closely studied, but even today there is much doubt concerning the phenomena encountered. Still more is this so with cast iron and its gas content. The technique of vacuum-fusion analysis has proved highly important in evaluating the gas content of both iron and steel, though it has its critics. However, it has been established that oxygen in cast iron is mainly in solution in the iron, and a characteristic grey iron contains from 0·001% to 0·025% by weight (Brit. Cast Iron Res. Assn.). Cast irons that have failed in service often show an abnormally high oxygen content, but if this content exceeds 0·02% it may not be the result of excessive oxygen content but of defective testpieces or those embodying occluded slags or oxides, as has been frequently demonstrated.

Evaluating notch ductility

One of the most essential properties in modern engineering materials is ductility, and this applies particularly to those irons known as nodular irons. Sometimes, when impact tests of these irons are carried out, using a notched testpiece, a degree of brittleness is found which is sufficient to cause service failure. Consequently, research has been devoted to evaluation of the notch ductility properties of these irons as a means of increasing the knowledge gained from study of the tensile properties.

Nodular irons are those obtained by adding 0·25% magnesium to the ladle during tapping, with ferro-silicon added for secondary 'inoculation'. Some of these irons are of ferritized and some of pearlitic type. As a result of the tests carried out, it has been found that for maximum notch toughness the nodular iron must be fully ferritized, with minimum silicon and phosphorus. High silicon and phosphorus produce brittleness. Thus if silicon exceeds 2·0% and phosphorus 0·01%, fracture becomes more frequent, whereas if the iron is held to the maximum given, the ductility or resistance to fracture is equivalent to that of ordinary cast or rolled low carbon steels.

Nodular irons at elevated temperatures

Ductile cast irons are those in which the graphite takes a spheroidal form, and are also known as nodular irons, as explained above. They are now standard materials and are extensively employed for numerous functions since they are not only comparable to the grey cast irons in ease of handling, but also have mechanical properties closely akin to those of annealed or normalized mild steels. There appeared to be a favourable prospect of using these materials at elevated temperatures, because of their higher resistance to grain growth and oxidation than the grey cast irons, but before this application could be advocated, it was essential to know the properties of the ductile irons at the proposed service temperatures, and particularly the creep and stress rupture properties.

Research was instituted which appears to have demonstrated that the short term tensile and rupture properties of pearlitic ductile iron are better than those of ferritic iron, and as long as the service temperature does not exceed 420°C, their creep strength is better also. When temperatures above 420°C are involved, however, the improvement is not maintained, and the nodular or ductile iron becomes unstable in microstructure, and eventually declines to a ferritic iron of lower creep strength than even standard cast iron.

Austenitic ductile iron, however, can be used with improved strength up to over 540°C, and can be safely used for long-term load-carrying applications at temperatures within the range 650° to 700°C taking into account both strength and resistance to scaling. The U.S. Naval Engineering Experiment Station gives the following data:

Temperature deg. F	Stress, psi for rupture in		Stress, psi for creep rate of	
	100 hr	1000 hr	0·0001%/hr	0·00001%/hr
700	45000	41000	27000	19000
800	30000	23000	13000	8200
900	18500	13500	6800	3900(?)

This table is based on a single ductile iron with a virtually complete ferritic structure, of composition 3·47% carbon, 2·49% silicon, 0·42% manganese, 0·55% nickel, 0·30% copper, 0·048% magnesium.

Mechanism of secondary graphitization

Still considering the ductile or nodular cast irons, it must be indicated that quenched structures of fully austenitized ductile cast iron when tempered show a change in microstructure known as secondary graphitization. This means that a considerable amount of secondary graphite in the form of small spheroids is formed, with at the same time a breaking up of the martensitic matrix in which the original graphite spheroids were embedded.

Metallurgists had no explanation for this, and research was therefore undertaken to see if the mechanism of this change could be determined. The various tests and experiments carried out have apparently shown that the various stages of secondary graphitization are (a) breaking up of the martensitic matrix into ferrite, and carbides of dendritic or tree-like type, rich in silicon; (b) swift decomposition of these carbides; (c) development of secondary graphite in a perfectly stable form. If the silicon content is increased, more secondary graphite is formed. On the other hand, if carbide-forming elements are added, secondary graphite forms at a slower rate.

Heat-treatment of ductile irons

After ductile irons had become standard, it was considered that heat-treatment of suitable character might improve their notch ductility and strength just as it does for steels, but the types of heat treatment

successful in achieving these effects with steels were obviously unsuitable for the nodular irons. It was essential to discover a method of regulating the carbon content of the austenite in these irons within prescribed and necessary limits by means of advantageous methods of heat-treatment. The first stage was to decide whether or not it was possible to achieve this, and secondly, if it was, to try to obtain as a result new grades of nodular irons possessing both high strength and good notch ductility.

Investigations revealed that the only way in which the desired results could be obtained was by avoiding a full austenitizing treatment, and employing instead a limited treatment. This involved heating the iron to intercritical ranges of temperature, maintaining it at temperature, and so producing combinations of tensile strength and ductility. The temperature range was 760° to 840°C and the period of temperature maintenance 4 hr (approximately). The quantity of austenite formed in the material could be controlled by increase of temperature within the range given, combined with a reduction of silicon content. Charts could be drawn up to serve as guides in this respect.

Tensile strengths could be obtained of about 40 tons per sq in., with a notch ductility equal to that of the un-heat-treated 27 tons per sq in. iron. Pearlitic irons of nodular type giving 40 tons tensile were markedly inferior in notch ductility to the quenched and tempered irons. On the other hand, if greater tensile strengths than 45 tons per sq in. were obtained, a sharp decline in notch ductility was experienced, and the only way of obtaining tensile strengths of this order was by the use of alloys.

One other interesting fact to emerge was that the irons of partly austenitized type could be water-quenched without cracking or distortion, whereas fully austenitized nodular irons readily cracked when quenched in water.

Malleable irons at low temperatures

Turning now to malleable cast irons, these, too, exhibit phenomena of notch ductility, i.e. the castings may break in service as a result of brittleness even when in the tests they showed good tensile properties. This is because brittleness may arise in a cast iron part as a result of notches resulting from some condition of service.

It has been considered that malleable iron castings might be used to advantage under conditions of low service temperature, and no data were known concerning the notch ductility of these irons at such temperatures. Consequently, a serious study of these irons as regards the required characteristics was carried out. This showed that if correctly manufactured, malleable irons were inherently notch ductile and suitable for use at low temperatures. The material is comparatively free from progressive fatigue fracture. Phosphorus must be held at a comparatively low value and must also be adjusted to the silicon content if low temperature service is envisaged.

The comparatively low maximum energy values of malleable irons in some notch tests have no relation to the development of brittle fracture. Such low energy values merely indicate that the material can be ruptured in shear with comparatively low absorption of energy if heavily overloaded.

New process

The making of nodular iron involves in modern practice the employment of magnesium as the 'inoculant'. Cerium has been used as an alternative, but has proved too expensive. Nevertheless, there are many drawbacks to the use of magnesium for this purpose. It is difficult to add to the molten iron; at high temperatures it may cause trouble owing to its reaction with oxygen in the air, so that it must be added in the form of dilute alloys, which increases the cost and may contaminate the metal. Hard spots are often found in nodular iron castings so made, reducing their ability to be machined.

It is not surprising, therefore, that attempts should have been made to discover some element other than magnesium that could be used with equal success and without involving additional cost. The result, after experiments with such elements as rubidium, calcium, sodium, etc., in various forms, has been a new process in which halides of nodulizing elements are employed in combination with such reducing agents as calcium. It has been found that commercial cupola heats can be achieved by means of mixtures of sodium and magnesium chlorides with calcium silicide as a reducing agent. The new process is said to be less dangerous and more satisfactory than the magnesium inoculation process because the castings produced are more easily machined, and the iron is ductile without need of annealing treatment or the addition of other elements with the nodulizing element.

Rupture of grey iron

Although a great mass of information is available regarding the mechanical and physical properties of grey cast iron, further data were required regarding its deformation and rupture. Accordingly, investigation has been carried out using thin-walled combined stress specimens, immersion type density measurements and microscopic methods. There appears to be little or no elastic behaviour. A density increase during plastic deformation is experienced, and is a smooth function of applied stress, being greater for biaxial tensile stressing than for uniaxial stressing. The cause is suggested to be the opening up and separation of the graphite from the matrix material.

The plastic lateral contraction ratio becomes greater as tensile stress increases. Fracture takes place in a direction normal to the maximum tensile stress, and may contain a few areas of brittle cleavage fracture. Ductile fracture takes place in local regions of high strain, and may produce a broad area of internal cracks.

Dry wear of cast iron

Extremely extensive tests of dry wear of cast irons of alloy type having widely varied microstructures have been carried out. A brake shoe testpiece was held against a revolving grey iron drum for one hour, after which both specimen and drum were checked for loss of weight. The conditions of this test show that wear is caused primarily by welding, though cutting wear may have contributed. The tests covered virtually all conceivable microstructures and a considerable range of compositions below 300 Brinell. It was found that microstructure decides the wearing properties. As graphitic microstructure coarsens, wear is decreased. Interdendritic graphite and its associated ferrite produce poor results. Secondary ferrite with random type graphite is also damaging, but less so. Pearlitic, acicular or tempered martensitic structures in the same range of hardness are equal in wear resistance. For a specific type of graphite, increasing pearlitization and hardness of the matrix causes higher degrees of wear resistance.

These tests have been confirmed in scuffing tests of cylinder sleeves in a diesel engine.

A.C. Motors and Controllers for Special Duties

A review of equipment made by Laurence, Scott & Electromotors Limited and now on permanent exhibition

SEVENTY-FIVE years ago a chance commission for the Hammond Electric Light Company brought W. H. Scott to Norwich and led to the founding of the well-known firm of electrical engineers, Laurence, Scott & Electromotors Limited. By 1888 the original partners, Paris and Scott, were producing reliable machines of a number of types and sizes and it is perhaps of interest to recall an early example which appeared in our pages in Jan. 28, 1888. Fig. 1, reproduced from the original woodcut, shows the Type C machine of 12,000 W output which we stated, had an electrical efficiency of 94·5%. Notable features were the deep slotted armature and a hexagon shaft and hole method of mounting the armature plates to resist high torques.

Since those early days the company has made many valuable contributions to the development of electrical machines and can justly claim to have pioneered many practical designs for industrial and marine-type motors. Much of L.S.E. equipment had special characteristics which have been developed for these applications and in order to make their products more widely known a permanent exhibition has been arranged at the Salhouse Road branch works, Norwich, where demonstrations of a.c. and d.c. equipment can be made under running conditions. The working exhibits include N-S, Ward-Leonard and other variable-speed motors with associated speed-control devices, Trislot high-torque, low-current, squirrel-cage motors, high-performance alternators and crane and winch control systems. Other exhibits displayed show examples of a.c. and d.c. starters and control gear, components and instruments and servo-equipment made at the Manchester works.

Motors and controllers for industrial duties

The N-S variable-speed a.c. motor, available for outputs of about one to 9000 hp, is a stator-fed variable-speed a.c. motor which can be adjusted steplessly in speed over a wide range under all loading conditions, without brush movement. Its induction regulator (which regulates the speed) may be operated by hand, by remote push-button, or from automatic devices of almost any required type.

Exhibits show a representative selection from the horsepower range

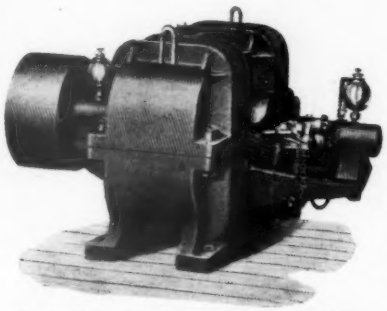


Fig. 1.—Paris and Scott's C type dynamo of 1888. This 12,000 W machine cost £100 and weighed 1300 lb

with appropriate control—hand, pilot-motor operated, "joy-stick" operated for small cranes and control by tapped transformers. Where the requirements are for accurate pre-set speed with precise speed control the Velonic control system is recommended. This electronic system will control the motor speed to within ± 2 rpm over the speed range irrespective of supply voltage and/or frequency variations of ± 10% and load variations from zero to full load.

A demonstration of automatic speed control is provided by the Asrec control equipment, which is a simple standardized system employing a sensitive polarized relay and stabilizing circuits with a d.c. tacho-generator and potentiometer for the signal and reference voltages respectively. The Asrec equipment is designed to cover, as far as possible, the very wide range of automatic control requirements in connection with N-S motors, from simple speed control such as that exhibited, to complex multi-motor process controls. The system will maintain a speed of the required value under varying load and supply conditions with a "steady state" accuracy of ± 1%, and for machines with a wide speed range (say 10:1) the accuracy referred to bottom speed will be better than ± 5%.

For operation and control of variable-speed, squirrel-cage motor the Speedmaster is available, a single-unit convertor for variable frequency a.c. supplies. The machine, based on the N-S variable-speed a.c. motor, comprises a stator of normal design and a rotor provided with both commutator and slip-rings. The speed of the set is controlled by an induction regulator connected to the commutator, alternating current at a frequency and voltage varying with the speed being delivered at the slip-rings. Frequency control may be effected by hand, push-button or automatic device, as for the N-S motor.

The exhibit demonstrating the salient features of Ward-Leonard variable-voltage control, is of interest insomuch that the motor, a 15 hp 100-V machine, was made in 1900 and is still in first-class condition. It was the first L.S.E. motor to have laminated pole caps and although not fitted with interpoles, commutation is good even under rapid switching. The motor is fitted with a friction brake for loading and is supplied and controlled from a "packaged" unit housing the Ward-Leonard generator and incorporating the control desk.

Two typical applications of low-frequency supply are shown; a section of a roller table drive with four motors supplied at approximately 3 cycles 55 V providing a direct drive at 60 rpm, and the method of providing stable crawl and inching speeds with a standard 50-cycle induction motor driving a platform. The use of low frequency has important operational advantages for drives involving frequent starting, stopping, continuous stalling, plugging and reversal. It enables a low speed to be obtained without mechanical gearing.

A.c. crane control system

The L.S.E. Revcon crane control system,* as applied to a single induction motor, gives stable control of speed throughout the wide range available, lowering and hoisting, to a degree quite impossible with a standard slip-ring motor. A model in the form of a crane hoist crab, approximately quarter full size, is mounted at a convenient height for observation on a 14 ft tower. Hoisting and lowering speeds are measured by an L.S.E. tachogenerator and indicated on a dial.

Equipment for marine duties

The major exhibits in this section represent the auxiliaries of a ship with a.c. supply, and are demonstrated under as nearly as possible working conditions. To meet the practical limitations of an exhibition, the electrical scale is approximately 1:10, but the same characteristics can be provided with much larger machines than those shown.

The usual ship's engine-driven alternator is represented by a 40 kVA a.c. motor-driven alternator set which supplies power to the motors driving the various auxiliaries. An a.c. motor is used in preference to a diesel engine, to permit full advantage to be taken of the high transient-current overload capacity of the alternator, which is as high as 300% full-load current when all motors are started simultaneously.

The auxiliaries are controlled by standard direct-on starters from a remote-control desk. The largest motor (16 hp, driving compressor) is switched on first, as is usual practice in an a.c. ship's engine room. The other auxiliaries are then started in descending order of size, so as to minimize the overload switching peaks on the alternator. However, the control desk arrangement permits, for demonstration, any switching sequence or combination, including all motors "on" or "off" together.

A novel indicator in the form of a column of light effectively shows at a glance the steady and transient loads on the alternator.

The alternator has special characteristics, suitable for its duty. It has Altoreg static compounding, which ensures inherently good transient voltage stability and steady-state voltage regulation, and is provided with an Asmag magnetic amplifier (i.e., static) voltage regulator, giving a steady-state voltage regulation of ± 1% to 1½% over the rated load range.

* Mechanical World, April, 1957, p. 183.

Part of the Laurence, Scott & Electromotors permanent exhibition at Norwich. The machines on the right-hand side include N-S variable-speed a.c. motors with different types of hand and automatic control, arranged for demonstration under working conditions. On the left are scale models of machines made by apprentice pattern makers

The motors are of the Trislot high-torque low-current squirrel-cage type (with the exception of one variable-speed machine mentioned below). This well-known type takes a lower starting current for a given starting torque than a normal squirrel-cage motor, and is therefore eminently suited to ships' installations, where large motors (in comparison with the alternator capacity) have to be started. A standard squirrel-cage motor is shown, for comparison of the starting current. One motor, driving a small draught fan, is of the N-S variable-speed type.

A compressor by Reavell & Co. Limited, of Ipswich, typical of their range of twin-cylinder marine compressors, is powered by a 16 hp Trislot motor, and a Drysdale vertical centrifugal circulating-water pump is driven by a 5 hp Trislot motor.

Other auxiliaries such as the steering gear and forward windlass are represented by Trislot motors.

Automatic tension winches

A quarter-scale model of the Pitt-Scott (Johnson type) automatic tension winch, mounted on a pontoon which can be raised and lowered, demonstrates accurately its performance when applied to mooring duties.

The Johnson-type winch is capable of checking the way on a vessel and, after it is moored, of keeping a constant selected tension on the mooring line, automatically heaving in or paying out with the rise or fall of the water. The motor is energized only when latching out or in to correct tension and cannot stall under any conditions. Rapid pay-out of mooring wires can be made when the ship is coming into dock or alongside and the slack wire recovered rapidly, after which the way on a ship may be checked quickly and smoothly. A clutch on the slow-speed barrel reduces the inertia of the moving parts, when required to slip under shock conditions. Clutch adjustable to slip at a value suited to the breaking strain of the wire used.

Other Pitt-Scott winches include a special-type winch developed for use on icebreakers, for towing through broken ice, and an interesting application for use in docking. Here the winches, which are mounted on the dockside and controlled from a central console, do not necessarily maintain a constant tension, but the pull can be automatically varied to maintain the ship central when moving in or out of the dock gate.

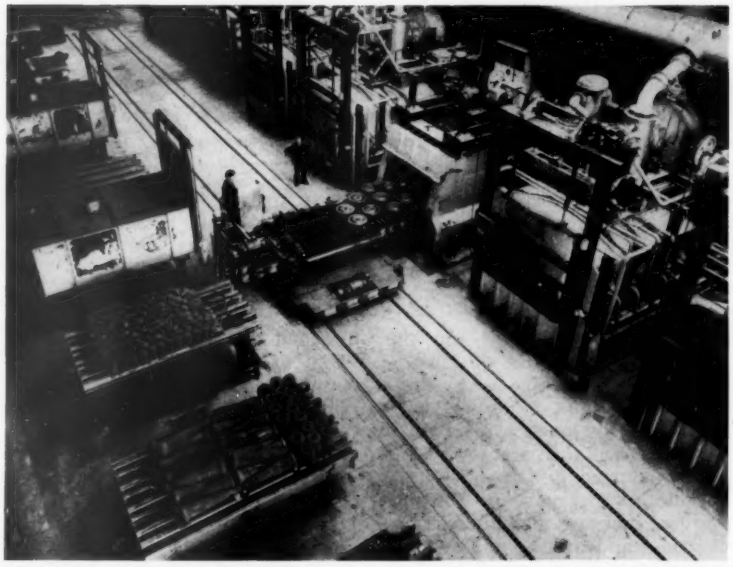
Heat Treatment of High Duty Stampings

New plant at the Darley Dale works of Firth-Derihon Stampings Limited

THE commissioning of the new central heat treatment plant at the Darley Dale Works of the Firth-Derihon Stampings Limited, Tinsley, Sheffield 9, which is comparable with any installation in Europe, has meant a reduction of 50% of the labour force previously employed on heat treatment, and also a reduction of 75% in the maximum number of heat treatment furnaces in operation. Previously the Darley Dale and Tinsley Works had been responsible for the heat treatment of their own production. Now with the installation of the new heat treatment plant at the Darley Dale Works, the complete handling of the whole of the heat treatment requirements of the company will be concentrated at these works.

When the Darley Dale Works were built in 1941/42 period, coke-fired producer gas plant was installed in conjunction with producer gas-fired forge reheating and small batch-type heat treatment furnaces and operated satisfactorily up to 1956. At this time the need for much greater accuracy of heat treatment procedure to deal with the whole range of the highest quality alloy and carbon steels, nickel-based and titanium alloys, together with increasing maintenance requirements of the gas producer plant merited a change over to the use of town's gas for all furnace firing and modernizing of the furnace equipment. The new plant, which incorporates many advanced ideas, was designed jointly with Gibbons Bros. Limited, Honeywell Controls Limited, Hartons Limited, and members of the Brown-Firth Research Laboratory. It comprises three Gibbons Dual-System town's gas-fired heat treatment furnaces, two Gibbons town's gas-fired tempering furnaces, a Gibbons oil quenching machine, a Gibbons-Van Marle turntable charging machine, loading cooling tables, and an instrument control room.

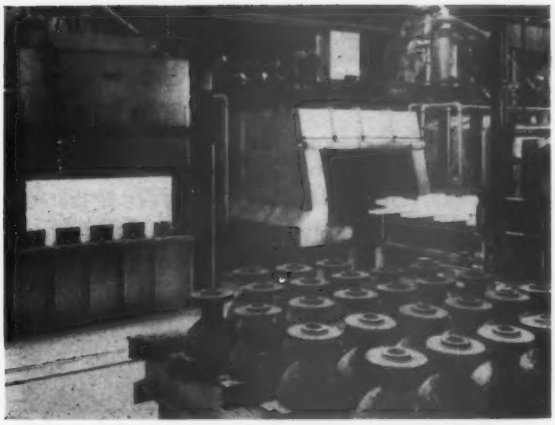
All furnaces are 11 ft long × 6 ft 6 in. wide and a height of 3 ft 3 in. to spring line of arch in doorways, and loads up to 5 ton can be treated in each furnace. The dual-system furnaces have normal operating temperature ranges of 200-750°C with forced recirculation, and 750-1250°C without forced recirculation, whilst the tempering furnaces have normal operating temperature ranges of 200-750°C with forced recirculation. Temperatures are electronically controlled by a fully automatic electro-pneumatic system, the Honeywell-Brown control instruments being housed in a centrally positioned air-conditioned instrument control room. The tempering furnaces are two-zone controlled and the dual-system furnaces single-zone controlled. Temperature distribution throughout the furnaces is held to extremely fine limits and is indicated and recorded at any six points in each furnace.



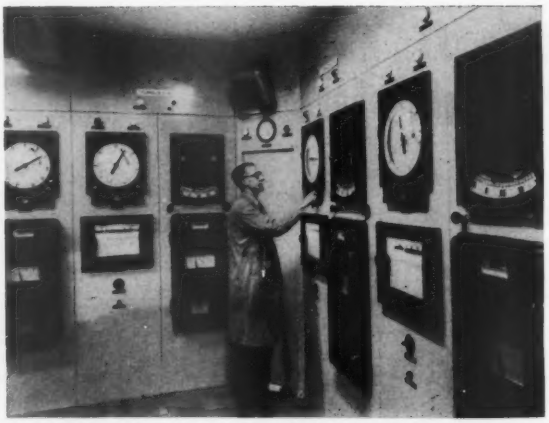
General view of the new heat treatment department. The rotating charging machine is withdrawing a batch of turbine discs from the oil quenching machine. The furnaces are located on the far side of the charging machine track, with the loading tables, slow-cooling chambers and forced air cooling table on the near side

All furnaces are fully instrumented and controlled to safeguard against failure for any reason. Compressed air supply for operation of the pneumatic control equipment is obtained from duplex air compressors and receiver units mounted on top of the control room, and the actuation of the air compressor units is also automatically controlled from the control room. Kent gas-flow recorders are used to record gas-flow rates, and total gas consumptions of each furnace. All waste gases from the furnaces are collected through a centralized overhead waste gas main and then discharged into the atmosphere via a high-capacity waste gas exhaust fan and chimney stack.

The oil quenching machine is of advanced design, being of the fully-enclosed type with automatic door operation. Automatic lowering and lifting of the load with variable-controlled oscillation of the load during the quench period is also incorporated to ensure the optimum oil flow conditions during the quenching cycle. For cooling the oil in the machine, the oil is drawn from the top of the tank; passed through a



Gas turbine discs being transferred from a dual-system furnace to the oil quenching machine



A view of a section of the interior of the air-conditioned instrument room

water-cooled oil cooler and returned to the tank via distribution ducts in the tank base. The oil cooler is capable of dealing with 27,000 gal of oil per hour using 12,000 gal of water per hour. Oil temperature is shown by an indicator on the discharge pipes from the oil tank.

The charging machine used in conjunction with the loading tables, furnaces and oil quench machine is an all-electric, four-arm turntable design arranged for 5-ton loads. Four motors are used for hoisting, lowering, charging and discharging, traversing and rotation. Power is supplied to the charging machine via a specially-designed motorized cable-drum unit, mounted on the charging machine, the feed cable being laid down in a small duct below floor level.

The general layout has been designed to handle large and small batch production efficiently and to eliminate manual handling as the plant has to deal with a wide range of forgings varying in weight from a few ounces up to about 800 lb. All incoming materials are received into the reception bay in stillaged form; forklift trucks and stillage trucks being used for the movement of all stillaged loads into the storage area, between the storage area and the loading tables, after treatment, and for the movement of stillaged loads to the adjacent inspection department. In the main heat treatment bay, electric overhead cranes are used for assembling the heavier forgings on the loading tables, etc. Dependent on the weight and section of the forgings to be treated they are loaded into special heat-resisting furnace trays or on to heat-resisting bearer-bars. After the load has been assembled on the loading table it operates as a unit load throughout all subsequent operations in the heat treatment department.

Jet-prop Test Bed

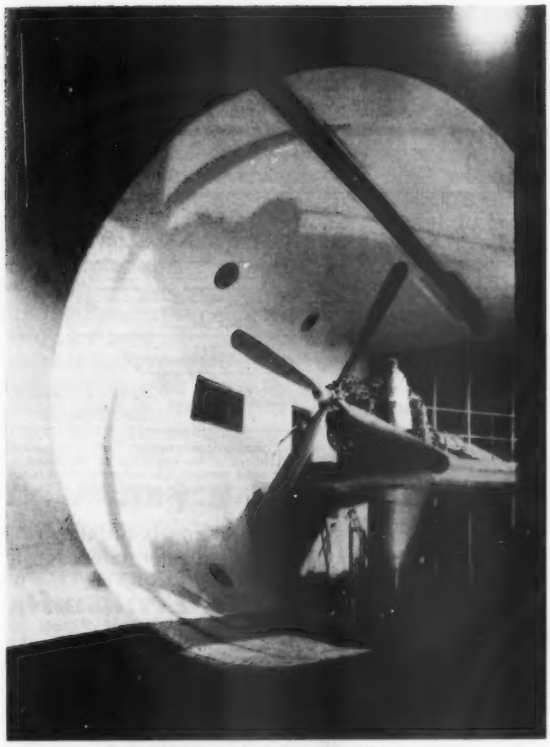
Aerodynamic twin cell installation for testing 10,000 hp engines

A NEW aerodynamically designed, twin cell test bed capable of testing jet-prop engines of 10,000 eshp with propellers of 20 ft diameter passing up to 4,000 lb of air per second has been opened by B.O.A.C. at the Nantgarw test site of their repair factories at Treforest, South Wales. The test bed is being used for testing the Proteus 705 jet-prop engines of the Corporation's 15 Britannia 102s and the Proteus 755 engines of its 18 Britannia 312s.

In designing the internal shape of the engine cells consideration had to be given to the possibility of vibration problems being caused by propeller excitation due to tip clearance in regard to the surrounding cell shape. Air re-circulation due to pressure difference also presented problems. Following investigation of a number of different shapes, the present circular test section, with a diameter of 28 ft giving a propeller tip clearance of 4 ft was decided upon.

The aerodynamic shape of the test section was specified by B.O.A.C. and it was constructed by British Reinforced Concrete in 8 in. thick pre-stressed concrete, which was cast in situ and post tensioned. An overall compression loading has been the aim, to reduce fatigue stress due to vibration. All the test equipment was designed to B.O.A.C.'s specification by Messrs. Heenan and Froude, who also supplied the equipment and were responsible for its installation.

In designing the structure for supporting the engine on test one of the main objectives was to present as little obstruction to air flow as possible, but at the same time the engine had to be readily accessible when idling. This was achieved by carrying the engine on top of a control streamlined steel column. This column in conjunction with its steel underframe will take the full power, weight and thrust of the power unit. It is also arranged so that torque reaction measuring equipment can be added later if necessary. At each side of the column just below the engine are "swept back" service ducts extending to the cell walls. These also act as engine access platforms from the control room and cell floor.



Proteus jet-prop engine being prepared for test

An interesting feature is the handrailing along each side of these ducts. It is electrically operated and made to rise with the opening of the control room door. When the engine is ready to run the handrailing can be made to recede into the leading and trailing edges of the ducts by operating a push button on the control panel. The handrailing does not therefore interfere with the airflow. A circular nacelle is mounted on top of the column and this carries the engine which is attached to a tubular mounting frame and backplate. Hinged swing bolts enable the engine assembly to be connected quickly. For propeller handling a hydraulically operated platform is provided forward of the test stand. This stand has to be retracted to floor level, before the engine is started. An electrical interlock prevents the engine from starting until the platform is fully down.

The control room is alongside the cell and has an observation window just above and a little towards the rear of the engine. Around the window is built the main control panel and this houses engine instrumentation, controls, indicator lamps and starting and switch panels. The throttle control for the Proteus is the Ultra type similar to that installed in Britannia aircraft. An alternative hand operated mechanical system is also included comprising levers, brackets and push/pull tubes. The de Havilland propeller control is of the hydraulic type. At one end of the control room and forming an extension to the instrument panel, is the engine oil system cabinet. This houses two quite separate systems for different types of lubricating oils. Provision is made for heating, cooling and filtering the oils, the oil/water heat exchangers and filters being below in the plant room. An inhibiting oil system is also installed for use at the end of tests.

Control room of one of the cells. Through the window can be seen part of a jet-prop Proteus engine on test

The fuel measuring instruments and associated items are contained in a separate ventilated cubicle beneath the control room. Flow indicating meters are remote reading with dials on the main control panel. Provision has been made for taking quick full specific gravity checks. In case of an emergency, there is a push button switch which closes the magnetic valves in the fuel line, stops the extractor fans and cuts off all d.c. services into the test cell.

For fuel storage, six underground tanks each 9 ft 8 in. dia $\times$ 32 ft long are provided. The capacity of each one is 12,000 gal. Fuel from these is pumped to the test houses, one pump serving each plant. Pump suction lines and tanks are interconnected, however, so that fuel from any tank can be delivered to either test cell. Adequate fuel filtering is provided. A separate high flow pump with filter and meter is installed for offloading fuel from supply vehicles into the tanks.

As a precaution against fire in the engine cell and fuel cubicle fixed CO_2 extinguishing plant is incorporated. The gas is contained in steel cylinders and can be released from several carefully placed operating points. In the event of gas being discharged interlocks automatically stop the engines, shut off ventilation, cut the fuel supply and operate an alarm device.

Engine starting is done electrically through a 112 volt rectifier set. The silencing of the test bed has been completely successful. The Cullum Pier and Panel system has been used in the air intake and exhaust with a Cullum Detuner for the engine jet exhaust.

On the civil engineering side the site required a completely new installation of all services, and was not merely an extension to the existing facilities at Nantgarw. In the final design (a reinforced concrete frame and brick panel construction) the cells were each made in three separate sections with separate foundations, and the workshop between is also completely independent of the cells. The test sections are on foundations of solid concrete 8 ft deep. The walls are mainly 14 in. reinforced brickwork except at the working section where they are 18 in. thick.

Construction of the test bed was started in March 1957, and the first cell was completed and ready for use in March 1958. The main civil engineering contractors were Messrs. W. C. French & Company Limited.

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Steel Belt Carries Magnetic "Messengers"

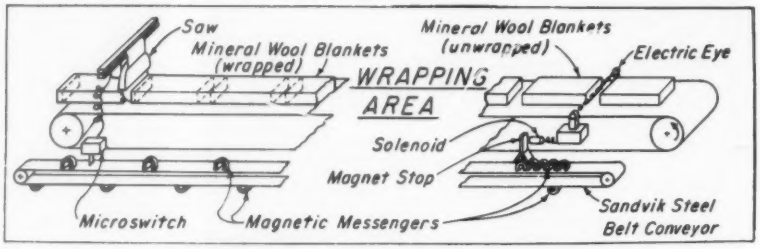
To avoid manual wrapping of mineral wool blankets, The Mineral Wool Insulation Company of California installed a packaging conveyor to wrap the individual blankets in one continuous strip as they move along the conveyor. This in turn presented a problem of how to cut the wrapping apart at the spaces between the blankets, as the spaces are not visible through the wrapping material and the blankets vary in length.

The solution was to design a remote control device comprising; (1) an electric eye at the beginning of the packaging line, (2) a 1 in. wide Sandvik steel-belt conveyor travelling at the same speed as and parallel to the packaging conveyor, (3) permanent magnets which are carried by the steel belts, and (4) a micro-switch control which operates the saw that severs the wrapping at the end of the line.

In operation, a stop holds back several magnets which have been placed on the steel belt. As mineral wool blankets travel along at the beginning of the packaging conveyor, the beam of the electric eye makes contact as spaces between the blankets pass between the eyes. When this happens, the magnet stop is released allowing one "magnetic messenger" to pass through and be carried along on the steel belt, in time with the space on the packaging conveyor. When the messenger gets to the micro-switch, it triggers this device and operates the saw which cuts the wrapping apart, exactly at the space between the blankets.

The magnet adheres to the return strand of the Sandvik steel belt, is carried around to the tail pulley and gets in line with the other magnets being held back by the stop.

Thus, the wrapping is automatically cut apart without damage to the contents and without the need for human supervision. Similar arrangements may be adapted to other problems where a remote delayed action is or may be keyed to some initial phenomenon. Such a device may be particularly helpful when the initiating occurrence is of an uneven or irregular nature.



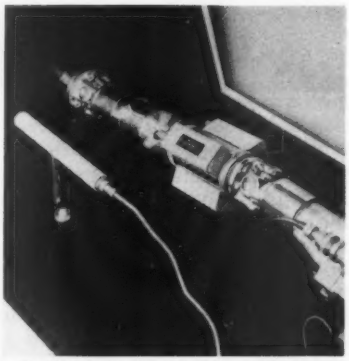
Schematic drawing showing how a Sandvik steel belt conveyor carries "magnetic messengers" which trigger the saw to cut the continuous wrapping of mineral wool blankets. The electric eye at the beginning of the packaging line releases the magnets as spaces between the blankets allow the eye to make contact. The magnets travel in time with the spaces and trigger the saw as the spaces line up with it. The magnets cling to the return strand of the steel belt and line up at eye-control stop

Electronic Inductive Coupling Transmits Strain Gauge Signals

Components vital to the operation of motor vehicles or which increase their efficiency are supplied in large numbers to the motor industry by member companies of the Birfield Group. Products of these companies range from propeller shafts to filters, and include some of the latest developments in plastics and the protective coating of metals. Research and development work for the group is carried on by Birfield Engineering Limited. The company was formed in 1957 for this purpose and to undertake the design of prototype for testing. Expansion of the already extensive facilities is being undertaken to cope with the full and mounting programme of road and bench testing of prototype components.

Much of the research and development work which Birfield Engineering Limited perform is done on test rigs designed by the company and constructed in their machine shops. Electronic instrumentation is extensively used for the observation of results. One example is a rig used for investigating the effects of changes of torque on a Hardy Spicer propeller shaft. It uses an electronic inductive coupling developed by the company's engineers.

Electrical signals from a rotating part to a stationary instrument have hitherto been normally transmitted through slip rings. This method has proved somewhat unsatisfactory,



The Birfield Engineering inductive coupling. Signals generated and amplified in the apparatus carried on the shaft, and modulated by the strain-gauges, are fed through the coil of wire round the left-hand end of the shaft to the stationary pick-up connected to the oscilloscope

because electrical contact between the rotating slip ring and the stationary brush is subject to interference from dirt, moisture or oil, and from variable mechanical conditions such as vibration or eccentricity. The inductive coupling has been evolved to overcome these difficulties, which are purely mechanical in origin, by the elimination of all mechanical connexions for the electrical system between the rotating and stationary parts. It consists of a coil of wire wound round the rotating part, and a stationary pick-up coil connected to the receiving instrument. Electrical signals fed to the rotating coil set up a magnetic field, which causes a voltage to be generated in the pick-up coil pro-

portional to the strength of the signal.

The inductive coupling can be used to transmit signals from strain gauges, fixed to the centre of the propeller shaft, to an oscilloscope which gives a direct indication of the effect on the shaft of changes in torque. This has been made possible by the development of tiny electronic oscillators for generating the signals and of transistors for amplifying them. These accessories, together with the batteries for supplying the power, are built into compact units which can be fastened to the rotating components in such a way that they do not disturb the balance. The electronic units, although tiny, are extremely robust, and are quite unaffected by centrifugal force.

The combination of the inductive coupling and the self-contained signal generating and amplifying units which can be carried on the rotating component is a notable advance in the technique of development testing, because the entire apparatus can be set up without any special machining or alteration of the component to be tested. In fact the inductive coupling coil can be wound in situ quite simply, thus avoiding the necessity for dismantling of the component. Another advantage of the system is that, by the use of more than one oscillator, several signals can be fed through one inductive coupling at different frequencies.

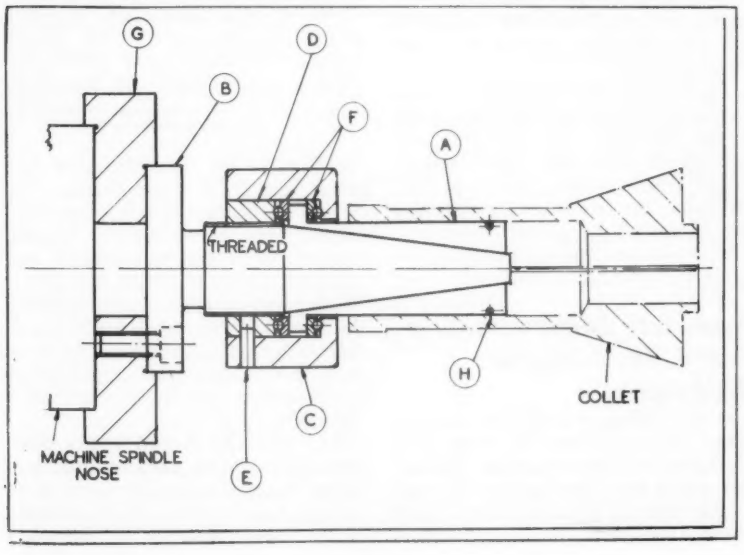
Expanding Mandrel for Grinding Collets

The accurate grinding of the closure taper and rear locating diameter of a collet is never an easy operation and repeated calls for this class of article will make it economical to design and manufacture a special holding fixture.

The fixture seen in the illustration has been in use for several years and the construction is such that grinding the two diameters is a matter of minutes, and as both are made at the same setting, concentricity is assured. The latter condition is not so essential at the front end but an opportunity is taken to skim this diameter as a safeguard against possible inaccuracies in the turning process.

Generally the most efficient method to adopt when manufacturing collets —and this applies from the minute variety to the more massive members —is to turn and bore the various diameters leaving the usual grinding allowances, mill the three or four slots, but without feeding the cutter completely through the material at the front end in order to prevent that portion from springing open at this stage. This requires the feeding of the slotting cutter downwards and then allowing it to traverse along until the required length of slot is reached; thus each slot has a small but essential "witness"—as little as an $\frac{1}{8}$ in. is sufficient because a narrow elastic wheel will soon grind away the surplus and give the collet the necessary degree of springiness. Heat treatment follows according to the steel maker's suggestions and then the piece is ready for final grinding.

Expanding mandrel for grinding the outside diameters and angular front end of collets



Location is obtained from the bore of the collet as shown, and for this reason it is advisable to impart to the latter diameter a somewhat better finish than is normally secured by drilling; a brief skim by a flat blade style of cutter removes the general roughness which drilling with a hand feed creates.

Three expanding segments A are used for location and holding (the illustration is not a true cross-section through a mandrel because of the difficulty of portraying equally spaced parts) and these pieces are operated by pulling them along the tapered portion of the expander B. The end where clamping takes place by means of the cap assembly C is firmly held, but the opposite end inside the collet needs a circlip—to prevent the segments from falling apart when the clamping pressure is released and the collet removed.

In this example a faceplate G is used to locate the remaining members and a recess bored to fit the spindle nose in the accepted manner is one method of ensuring the required concentricity, but the screwed type of adaptor or a taper fitting the spindle nose are other ideas easily applied when necessary.

The cap assembly C is interesting because it contains two thrust bearings to minimize wear caused by the tightening action. To permit assembly a separate threaded portion D is used. This is threaded into position after the segments and races are fitted, and a small pin E is driven through C into D to eliminate radial movement. Care in fitting the parts together is essential as a relatively free movement is necessary to avoid the segments turning as they commence to clamp the collet.

Both the inner surfaces of the cap C and the insert D require machining to make a seating for the balls and this track is subsequently case hardened to counteract wear. Each part thus takes the place of the discarded race ring, and a similar process is required for the segments to preserve the flat edge where the races contact. Incidentally the machining of a parallel hole by means of the blade cutter mentioned above, means that the segments contact for the complete length and not at one particular point.

While a hexagon milled on the cap will allow tightening, there are occasions when a spanner exerts too much pressure and unless care is

taken there is danger of crushing the balls or damaging the tracks. For this reason a series of tommy holes drilled partially through the cap is preferable. The holes are not drilled right through so dust cannot enter the cap and so ruin the races. For this reason also the segments should fit closely.

Despite the long overhang (the drawing has been somewhat exaggerated in an endeavour to illustrate clearly), a rigid and accurate assembly is obtained and the collets are ground at a single setting and without a sign of chatter. A quarter turn of the cap is sufficient to release the pressure and a thread of about 20 tpi is suitable.

Ball Bearing Scribing Block

When a very heavy scribing block is used there is a great deal of friction between the base and surface plate and the task of moving it requires considerable effort.

The marking out of large turbine casings demanded the use of very high equipment, the bar being some 6 or 7 ft tall and made from 1 in. steel bar, and the weight of this plus the base meant that carrying it round to the other side of the casting was out of the question. The use of balls as a rolling medium reduced the exertion to a minimum.

In order not to destroy the flat surface of the actual block because such a face may be necessary on other work, it was decided to mount the block in an adaptor holding the balls. To ensure an adequate hold, the sides of the base A were tapered about 10°, and with the aid of the two socket-headed screws C secure clamping to the rolling base B was obtained.

Efforts to drill down and leave a cone to hold the balls were not successful, and it was found easier to recess the rolling base and substitute retaining plates as shown at E; the latter being coned to fit snugly round the ball, and they were carefully checked to see that no restriction was placed on the ball when assembled.

The depth of the balls was controlled by socket grubscrews. The one immediately above the ball was ground on a surface grinder to provide a smooth flat surface and the one above was used as a locking screw to retain the first in the correct place. Fig. 2 makes this clear.

The provision of four feet meant that one had to be adjusted by the grubscrews. A strip of cigarette paper was placed underneath each ball; when all refused to pull away the setting was satisfactory.

The balls did not fit in the cone of the recessed plate—the weight of the block and adaptor caused the grub screw to press hard on the ball thus some clearance between cone and ball was of no consequence.

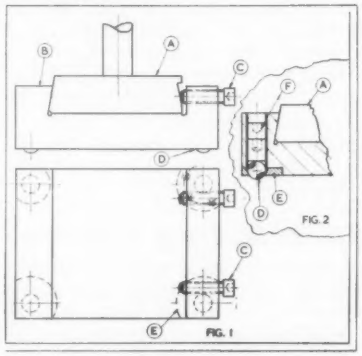


Fig. 1.—Base with the adaptor in place. The coned plates are held by three small screws. Fig. 2.—Cross section through ball cavity showing the method of setting to ensure that all touch the surface plate together

For the purpose of ensuring an even weight distribution on all the balls and to provide some form of gauge to enable a marker-out to reset the block once the initial setting had been disturbed, the adaptor was made the same length as the block; thus on again offering the block the edges were aligned and the screws tightened.

If the bases on the scribing block are circular instead of square, it becomes a simple matter to bore a recess to an easy fit over the base and drill four deep drill points for the screws to hold it securely instead of the angular edge shown in these drawings.

The time saved in marking out these large castings was not really calculable as the operation was a lengthy one and much time was spent setting rather than actual marking out. However, the freedom of movement was an obvious benefit as there is now no heavy pushing and shoving to bring the block into position.

Special Micrometer for Checking a Recess

The machining of a shallow recess a short distance down the bore of a workpiece seldom presents difficulties unless the hole diameter is small as this restricts the size of a tool and causes the latter to bend and perhaps severe chattering, but the checking of these parts to ensure that the wall thickness has not been impaired is not easy or simple and the use of the caliper type of gauge does not really give an accurate reading.

The brass sleeve shown in Fig. 1, produced in large quantities on a six spindle automatic, required a percentage check on the bore—gauging every article was not necessary as carbide tools meant a lengthy run before any alteration in the setting became essential—but inspection requirements made the construction of a simple micrometer type of gauge worth while and meant that each piece was gauged to the desired tolerances by unskilled labour without any serious problem arising.

The body A is turned from a piece of rectangular bar—carbon steel which will case harden is necessary and preferably one that does not distort as this latter disagreeable feature can ruin the threads—and this initial operation of turning will entail the machining of the outer diameter, recess for the spring E and

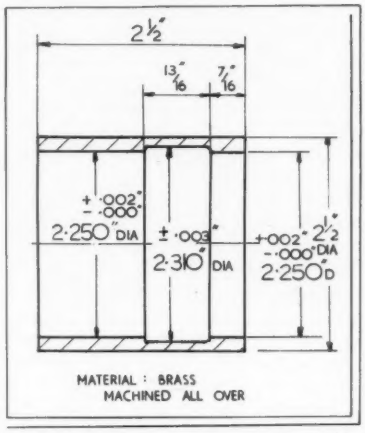


Fig. 1.—Typical sleeve type component where checking of the wall thickness is essential

shaft D and the outer threaded diameter, all at a single setting. The boring of the anvil holes is best performed on a milling or boring machine after the rectangular head has been milled to shape, and this is followed by case hardening. Lapping the threads clears away all traces of scale if no steps have been taken to exclude this, and this operation is soon carried out by the aid of a copper lap.

The thimbles B and C are comparatively simple turning jobs and unless deemed essential, there is no point in knurling the outside diameter of the larger member as the small

diameter of B gives a faster checking time.

The shaft and anvils require case hardening in order to resist wear as continued pressure at one point by the spindle D will eventually cause a ridge to appear unless steps are taken to provide a hard skin, so the small taper is treated by Kasenite and afterwards polished to make a good seating against the sliding member G.

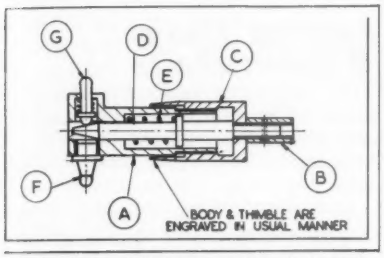


Fig. 2.—Gauges of this type are easily made in a tool room if the threaded diameters are not too small

Silver steel is best material for this —again hardening is necessary—and because the piece is so small, case hardening is perhaps not the most appropriate process. Finally, the fixed part is turned, hardened, polished and assembled to the body with special precaution to see that the fit of the threads is tight to prevent any suggestion of slackness developing during frequent usage. For tightening purposes hexagon material is useful.

Engraving presents a problem when constructing gauges of this nature, but with the aid of a dividing head on a milling machine and a single point tool set on a special adaptor in the head, the work, though tedious, is not difficult. Alternatively, there are firms who undertake this type of engraving.

Gauges of this design have one disadvantage—the amount of movement available to the moving anvil G is limited to the degree of taper imparted to the spindle D, but as in this case the component recess is not much larger than the bore of the sleeve, this problem did not arise. The chief advantage is the accuracy achieved by using this method and the fact that care is always exercised when using any micrometer means errors seldom arise. The retraction of the moving anvil is a matter of a second or so as the movement of the smaller spindle withdraws the spindle and permits the springs to return their respective details to their initial positions. If necessary, these gauges are easily mounted on a stand and unless parts have exceptionally close tolerances, there is no need to provide three anvils.

Drilling Holes Radially in Large Cylinders

Drilling holes in large diameter cylinders or rings when a jig is not available and the position of the holes has been previously marked out, demands that the centre line of each bore is set accurately vertical in relation to the machine spindle. With work having thin walls the error may not be serious, but when the drill must enter for perhaps a distance of three or four inches, setting is important especially when holes on opposite sides of a workpiece must match each other fairly closely in order to allow a shaft to pass through. A cross section through a typical component is given in Fig. 1.

Efforts are often made to mark lines on the edges of cylinders in an endeavour to facilitate this setting, but this is not always practicable and a much more convenient method is to use the device shown in Fig. 2. This consists of a V-shaped body A: a brazed construction is an economical way of making this point, but a section sawn from ½ in. thick brass is quicker, and holes can be drilled to reduce the weight if considered necessary.

A cross hole is bored to accommodate the pendulum pivot B, and as this actuates back and forth, aluminium is the best material because of the saving in weight and when the bearing diameter does show signs of wear—a condition only apparent after months of regular use—it is a simple matter to replace the piece.

Attached to this pivot is a long steel rod C turned to a sharp point at the lower end and held to the pivot by means of a knurled screw D; thus it becomes possible to lengthen or shorten the pendulum according to the component being drilled. At the pointed end of this rod is the weight E which causes the device to swing and though lead is the traditional material brass is sufficiently heavy and is more durable. The part is held to the rod by a socket-headed grub-screw.

The drum, cylinder or ring is placed in V-blocks which allow it to rotate, and after an approximate setting is made by eye, the device is stood on the outside diameter as shown in Fig. 2. The pendulum being free to rotate takes a vertical position,

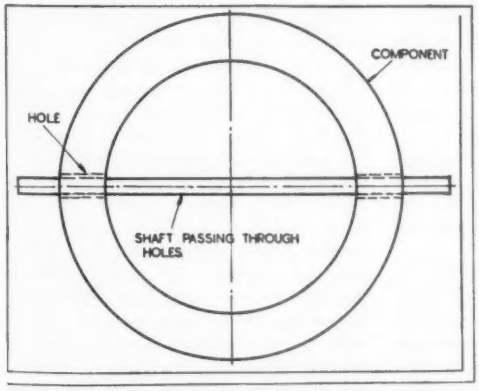


Fig. 1.—Typical case where holes drilled angularly would not allow a shaft to assemble

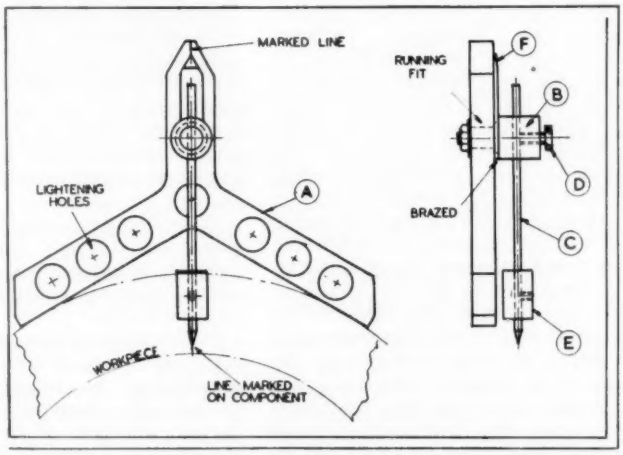


Fig. 2.—General arrangement of setting device showing it in position on a cylinder correctly set for drilling

and by moving it round the cylinder the pointer F attached to the pivot is aligned with the line scribed on the body. Incidentally, this line is accurately marked from the two feet when the latter are resting on a perfectly flat surface.

The initial setting with the marked component will undoubtedly indicate that the hole centre line is not placed vertically, and further adjustments must be made before the pointer matches the component line and the opposite end corresponds to the pointer line at the far end. When both match correctly, the hole centre line is set vertically and in relation to the drilling machine spindle.

Metal Sputtering for Printed Circuits

Recent research in the field of cathode metal sputtering at Bell Telephone Laboratories indicates that this century-old technique may be useful in producing precision printed circuits for modern communication equipment. It now appears that entire circuits, including resistors, capacitors, and leads, may be laid down by this technique, in which ionized gas molecules bombard a cathode, dislodging atoms of metal which then redeposit on nearby surfaces.

Harold Basseches of Bell Laboratories has produced thin films of a number of electrically interesting high melting point metals. Tantalum and titanium for example, melting at 3000°C and 1670°C respectively, can be laid down in films which show sufficiently high resistivity to be useful as resistors in printed circuits. With proper masking of the substrate, lines and patterns of practically any desired shape and size can be formed, ranging in width down to a few mils. These sputtered films generally are between a few hundred and a few thousand angstroms thick.

In addition to pure metals, alloys such as those of nickel-copper and nickel-chromium can be sputtered without difficulty, apparently retaining their approximate original composition.

R. W. Berry, also of Bell Laboratories, has produced "printed capacitors" by a combination of sputtering and chemical methods. A tantalum film of the proper shape and size is first sputtered on to the substrate and then anodically oxidized to form a tantalum oxide dielectric film. The counter electrode, a film of gold, can then be evaporated on to the dielectric to form the completed capacitor "sandwich".

Copper leads can be sputtered without difficulty to connect the various components. The technique is attractive since it eliminates the need of any organic adhesives.

While some disagreement still exists as to the exact mechanism of cathode sputtering, its effect can be easily described and recognized.

Sputtering apparatus used in preparing resistor film

These effects were first noted in 1852 by W. R. Grove, and in 1858 by J. Plücker.

In cathode sputtering, a plate of the metal to be deposited is used as a cathode. The substrate on which the film is to be deposited is placed on a table close to the cathode. After evacuation, argon or other suitable gas is introduced and maintained at a pressure of approximately 20 to 40 microns.

When a voltage is applied, ionized atoms of the gas bombard the cathode, dislodging metal atoms or clusters of atoms, which then deposit on the substrate.

In "reactive sputtering", films of inorganic compounds are formed by introducing a small controlled amount of a reactive gas such as oxygen, nitrogen, or hydrogen sulphide into the apparatus. Compounds which can be formed in this way include the oxides, nitrides, and sulphides of a number of metals.

Sputtering is one of the most convenient methods available for the production of thin films of high melting point metals. In general, films produced by sputtering are strongly adherent. Another inherent advantage of sputtering is that the thickness of films so produced may be controlled within narrow tolerances.

Laying Long Welded Rails

The Chief Civil Engineer's Department of the North Eastern Region has devised and adopted an entirely new method of laying long welded rails.

A train of 11 "Salmon"-type bolster wagons with a total length of about 700 ft is used for the operation. Up to 36 welded rails, 300 ft in length, can be loaded on to the bolster wagons at the new rail welding depot at Dinsdale near Darlington and pairs of these rails are fishplated together to form 600 ft lengths (eventually continuous welded rails 600 ft long will be available). The rear wagon of the train has a special gantry equipment which has been designed for guiding the lengths of rail off the wagons at normal rail spacing of 4 ft 8½ in. and for lowering the rail ends.

Before starting laying, the rail ends are anchored to the track by 60 ft steel wire ropes and the eleven wagons are drawn forward by a 350 hp diesel electric shunting locomotive until the first 70 ft of each pair of rails is clear, and the ends of each length have been deflected down to the level of the rails in the track. During this part of the operation the first pair of existing short rails is tipped out manually from its sleeper seatings. The train is stopped and the ends of the long rails are put into position in the vacant sleeper seatings. The ends of the long rails are then fishplated to the existing track and the wire ropes removed. Thereafter the train is kept moving at a constant speed of about 30 ft a minute (the short rails being tipped out in pairs as the rear wheels of the last wagon move clear) and the 600 ft rails are guided into their sleeper seatings by men using bars. When the free ends of the first pair of 600 ft rails have reached a position on the wagon next to the gantry wagon, the train is stopped and the rails are fishplated to the second pair of

600 ft lengths. This cycle of operations continues until the last pair of rails is being drawn off the wagon.

When only two or three feet of long welded rail remains to come through the last pair of rollers the train is stopped and the rail ends lifted just clear of the bottom rollers by chain lifting blocks suspended from a lowering gantry. The train then moves forward a few feet and when it is stationary the rail ends are lowered into their sleeper seatings.

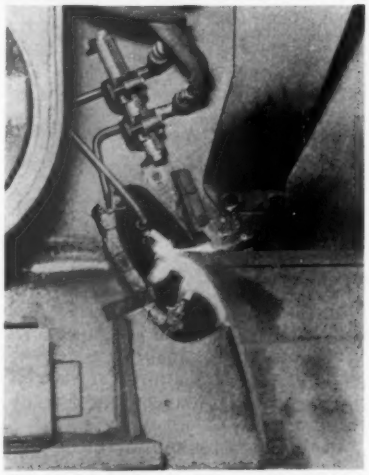
The traditional open-gapped joint has come to be generally accepted as necessary to allow for the normal expansion of rails following rises in temperature. Steel rails, in common with other materials, will, when unconfined, expand or contract as temperature varies, but such movements can be counteracted by the imposition of a balancing compressive or tensile force on the rail which will maintain it at constant length. In practice, rails are not entirely free to move because of the frictional forces developed at their chair or baseplate seatings and by their fastenings, the extent to which movement occurs depending on the type of fastening. In the case of the spring-loaded type now used with long welded rails, movement has been virtually eliminated and conditions are such that the expansion or contraction that would have occurred had the rails been free to move, has been counteracted by compressive or tensile forces developed within the rail itself. In consequence, the rail remains at constant length, except for short distances at either end where the friction developed by the fastenings is insufficient to balance the force within the rail.

The length to which rails can be safely welded is governed only by practical considerations such as the presence of switch and crossing work, insulated joints used in connection with track circuiting and the maximum length of rail it is reasonably possible to handle when relaying is being undertaken.

Flame Descaling in Tube Production

The tube works of Stewarts and Lloyds Limited at Coatbridge was recently faced with the problem of removing mill scale before the seam-welding of steel tube could be carried out. The importance of cleanliness in the weld meant that a descaling operation had to be introduced. For the purpose British Oxygen Gases Limited assembled special flame cleaning equipment which was fitted to the slitter beam of the tube forming and welding machine. This equipment comprises a 2 in. flat nozzle directed on the outside of the tube and a 3 in. flat nozzle directed on the inside.

Gas setting of the nozzles is adjusted by means of the rack, and angle adjustment is also provided. The oxygen and acetylene supplies are controlled by a duplex valve. Driven by friction rolls, the tube, already shaped for welding, passes at a constant speed through the machine. A pair of edge forming rolls "tighten" the shape of the tube which then passes between the two descaling heads. These are poised so that both sides of the open seam, along which the welding takes place, are subjected to sudden intense heat. This causes fairly violent differential expansion and contraction over an area of $\frac{3}{4}$ in. on each side of the plate, thus cracking off the heavy scale. The tube then moves on between two further pairs of friction driven rolls and a mechanically-driven wire brush ensures the removal of all final traces of scale. The tube then enters the welding zone of the machine where the edges are fused by the submerged arc process.

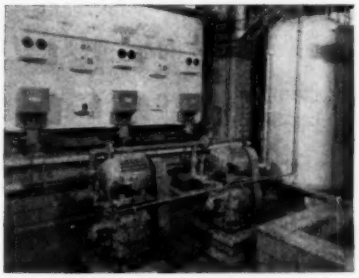


Close-up of flame descaling process with a tube just beginning the descaling run. The pipes feeding the nozzles are made of Monel and the lower one is asbestos covered

This method has proved reliable and simple to operate, and the equipment was rapidly installed at a fraction of the cost of shot blasting equipment. Tubes up to 27 ft in length, 18 to 50 in. dia and $\frac{1}{4}$ in. to $\frac{5}{8}$ in. wall thickness can be dealt with.

Hydraulic Operation of Salt Valves

An automatic pressure system to provide a constant water supply for the hydraulic operation of salt valves, has been installed recently by the Middlewich Salt Company Limited, Cheshire. The valves, which are an essential part of the plant used in the production of salt, are operated on a time cycle by water supplied from a pressure vessel at a pressure of between 65 and 80 psi. The required pressure is maintained automatically



Megator automatic pressure system to provide a constant water supply for the hydraulic operation of valves which form an essential part of plant used in the production of salt

in the vessel by two Megator M 16 cast iron sliding-shoe pumps—main and standby—each capable of supplying 800 gal of water per hour at a maximum working pressure of 85 psi.

In the pressure lines between the pressure vessel and the three salt valves is the control panel, on which are mounted three solenoid-operated changeover valves operated by time switches. During the cycle of operation, each changeover valve in turn admits water under pressure to the appropriate salt valve.

The pressure system equipment, comprising pumps, pressure vessel, pressure switches, automatic starter and selector switch, was supplied by Megator Pumps & Compressors Limited, 43 Berkeley Square, London W1, and although used in this instance for a special industrial application, is generally similar to that widely used in the marine field.

Fabricating Honeycomb Structures

The need for a metal core for flying surfaces which can withstand high temperature generated by supersonic speeds has led research engineers of the Boeing Airplane Company in the United States to experiment

The honeycomb (left) can be shaped in contours when supported by ice. A friction disc cutter (right) trims the metal honeycomb. The tool was evolved from an engine valve stem

with metal honeycomb made of stainless steel. The steel core will be sandwiched between sheets of titanium, the two metals being brazed together with a lithium-silver foil in ovens at 1325°—1390°F.

The present use of aluminium honeycomb includes portions of the trailing edges and control surfaces where other types of internal stiffeners had strengthened skin panels. Bonded honeycomb has proved to be superior in jet aircraft to structures previously used. Research engineers were confronted with the problem of how to shape, size and trim this delicate metal. The thin walls of aluminium honeycomb were mauled by conventional milling pieces until a unique tool, called a "friction disc cutter" was tried. This cutter evolved from the valve stem of a truck engine. The face of the flared end has been sharpened and the stem is installed in a cutting mill. Now, the thin, unsupported honeycomb walls can be trimmed away in neat layers. Cutting the metal core with regular milling tools is done after freezing the honeycomb in ice, then placing it on a shaping mill and contouring to size as specifications require. The honeycomb is adhesive-bonded in an autoclave by the metal-bond process. The sections are put in a platen and firmly clamped by internal vacuum. The whole is then put in the autoclave and subjected to 350°F temperature.

Post-weld Annealing of Stainless Steel

The process of annealing stainless steel serves a dual purpose—weld stabilization and stress relief. Weld stabilization is achieved by dissolving inter-granular chromium carbides precipitated in the narrow zones adjacent to the weld, thus restoring chromium to the depleted boundary areas. Stress relief is required if work-hardening occurs in the fabrication process.

In the case of austenitic stainless steels, most commonly used for welded tubing, the extent of carbide precipitation is largely dependent on the amount of carbon present and the time of dwell in the temperature range of 450/850°. Any prolonged heating in this critical temperature range increases carbide precipitation. It is therefore necessary to attain the solubility point of the carbide (850°) as quickly as possible if the annealing process is to be effective.

The high temperatures involved also promote scaling in all but a completely inert gas atmosphere. While this scale can be removed by pickling, the remaining surface is rough and reduces corrosion resistance.

In the case of batch tubing of long lengths, the required conditions for proper annealing cannot be fulfilled because the bulk and shape make it virtually impossible to heat and cool rapidly and because trapped air and other gases cause internal surface corrosion and scaling.

In view of the impracticability of providing the necessary rapid transition to the correct annealing temperature and similar difficulties in the quenching of large fabrications, two grades of weld decay-proof stainless steel are produced to obviate the necessity for post-weld heat treatment:

1. Stainless steels with an extra low carbon content, e.g. Samuel Fox's 620, and Firth Vickers' FSL, equivalent to American specifications AISI 304L.
2. Stainless steels with strong carbide forming elements such as titanium or niobium, e.g. Samuel Fox's 22, and Firth Vickers' FDP, equivalent to American Specifications AISI 321 and 347.

Even with these grades of stainless steel, inter-granular precipitation can occur leading to attack in the weld boundary if the correct heat treatment is not applied. Under these circumstances and in view of the complex chemical reactions in which time is an important factor, the most effective method of obtaining the maximum corrosion resistance of these stainless steels is by rapidly fusing and quenching during the welding process.

While maximum corrosion resistance is maintained without post-weld annealing, these materials are subject to work-hardening, and annealing is therefore required if the material has been severely bent, stretched or compressed. In the process of forming tube from strip negligible work-hardening takes place provided the strip width is correct and that no compression is required to reduce the tube down to size after welding.

The process of annealing stainless steel is beset with many difficulties and equipment has not yet been developed to fulfil all the conditions required for long lengths of tubing. In the solid drawing process where material is heavily worked, annealing is essential notwithstanding its shortcomings. To overcome these shortcomings, research and development work is taking place at the factory of Rollo-Hardy & Company

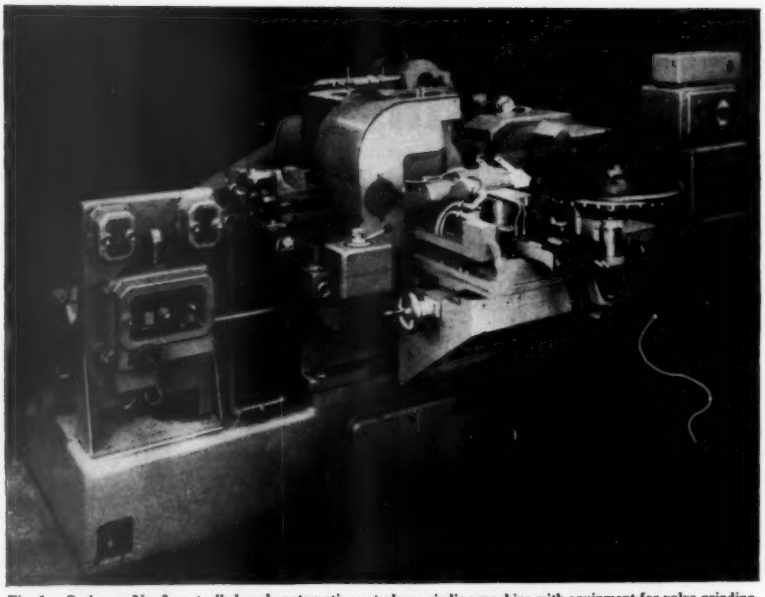
Limited, the rigid tube division of the Compoflex Group. This work consists of perfecting heating arrangements to provide the correct annealing sequence and developing welding and finishing processes to ensure maximum corrosion resistance.

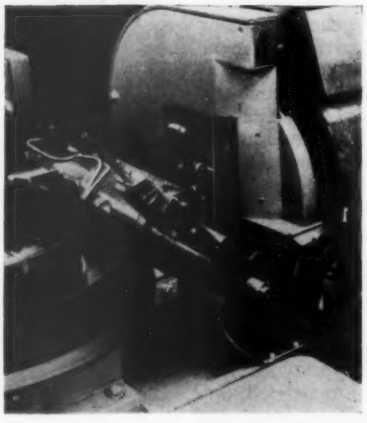
Where tubing is formed from accurately-cut polished strip and welded quickly by the most suitable method, post weld heat treatment is best avoided and only resorted to where the softest possible condition is required. Tests show that Permbrite rigid tubing is sufficiently soft for most purposes and that the increased cost of annealing is justified only in special cases.

—M. W. Wilson.

Automatic Valve Grinding

The centreless grinding of automobile valves on the stem is performed as a fully-automatic operation on a No. 2 controlled-cycle Scrivener centreless grinder. The machine, which has a grinding wheel 20 in. dia, is equipped, as will be seen from Fig. 1, with a rotary magazine into which the valves are loaded, and a transfer finger mechanism which at the commencement of each cycle picks up a piece from the magazine and lays it on the workplate between the wheels in the manner shown by Fig. 2. At this point, the control wheel advances the piece to the larger wheel, where it is ground, after which the wheels open and the piece is ejected into the tray in front of the machine. Indexing of the magazine, transfer of the piece to the machine, grinding and ejection are all automatic and synchronized with the operation of the controlled cycle of the machine. The maximum size of valve which can be dealt with on this particular machine is 8 in. under the radius, this being fixed by the widest wheel which the machine will mount.





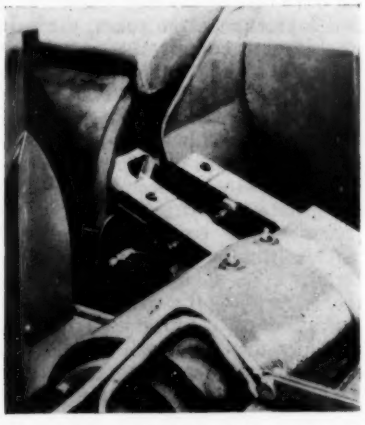


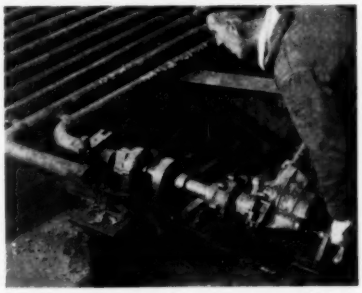
Fig. 1.—Scrivener No. 2 controlled-cycle automatic centreless grinding machine with equipment for valve grinding Fig. 2 (bottom left).— Transfer finger has picked up valve from the rotary magazine, and is about to transfer it to the workplate between the wheels of the centreless machine. Fig. 3 (bottom right).—Piece has been deposited on the workplate, and the transfer finger is swinging back to pick up a fresh piece ready for the next cycle

Simple Rig for Weld Preparation

Reduced cost and greater output in the preparation of tubes for butt welding have been achieved at the Glasgow works of John Brown Land Boilers Limited by the use of simple portable rigs which are easily moved about the works, thus allowing machining to take place at any convenient location and eliminating the need for expensive horizontal boring and facing machines which would require the work to be brought to them.

Each rig consists of a Consolidated Pneumatic type 350-R-100 heavy duty power vane drill mounted in line with two ball races and a vice on a common baseplate. The drill is fitted with a No. 5 morse taper spindle which is held rigidly by the ball races spaced 5½ in. apart. A specially designed cutter head carrying two Cleveland twist drill cutters of 10% cobalt steel is mounted on the spindle, the head carrying recesses for cutting teeth suitable for dealing with tubes in the size range of 1½ in. O.D. to 6 in. O.D. and thicknesses of from 10 gauge up to ½ in.

A particular feature of the assembly is that whilst the rig allows of working to within limits of 0·005 in., only semi-skilled labour is required for its operation and head change is accomplished in a matter of seconds by the operators.



Preparing butt welds with a pneumatic vane drill in a special rig. The tubework is a secondary superheater element of an 860,000 lb/hr boiler being fabricated in chrome alloy steel for the C.E.G.B.

Weir Multiflash Evaporator and Distilling Plant

The demand for fresh water is expanding rapidly, and often in places where natural supplies are inadequate or not to be had. The development described below marks a major advance in the conversion of salt-laden water into fresh water.

By GEORGE W. McARD, A.M.I.Mech.E.

IN the August, 1958, issue of MECHANICAL WORLD an article appeared describing the method by which the conversion of sea water to fresh water had been so effectively accomplished. As in many other spheres, success has served here also as a spur to further achievement, the outcome of continued research combined with the experience gained from numerous installations in different parts of the world being an evaporating unit of the flash type having features of striking technical interest. All plants hitherto supplied for sea water conversion have been of the multiple-effect submerged-tube type in which the heating medium—steam or vapour—passes through the tubes and boils the brine which surrounds the tubes, the vapour generated from one effect becoming the heating medium for the next effect.

In the early 1930s, however, an alternative scheme was investigated in which the brine was passed inside the heating tubes without being allowed to boil, and vapour condensed on the outside to give the required heat. After its temperature had been raised, a reduction in pressure of the brine would cause part of it to flash into vapour, a result which could be produced in a somewhat similar fashion to the multiple-effect process. But certain other factors arose which were detrimental in themselves to the really successful and continuous operation of a conversion plant of the flash type on the lines then followed, factors which called for much concentrated research work before the defects manifested were eliminated. The further investigation carried out has not only removed the defects—these involving problems connected with scale formation, impurity of final water supplies, and cost of production—but actually made it possible to operate the "flash" process on an appreciably lower steam consumption per 1000 gal of pure water delivered.

This question of cost will figure very prominently in the days ahead when older catchment plants have to be replaced or/and provision made from scratch for new urban areas which will develop from the rise in population. Figures have been published which confirm the fact that the current costs of water from existing catchment schemes work out from 1s. 6d. to 2s. per 1000 gal; these are for plants laid down many years ago when capital costs were well below to-day's level, costs that could easily be doubled in new water undertakings of this type. Water produced by the latest scheme, the Multiflash process, can compete successfully with some higher cost catchment schemes, proof of this assertion being forthcoming in the contract recently placed with G. & J. Weir Limited by the Guernsey Water Board, and in the increased economies in steam consumption

G. & J. Weir, Limited

Fig. 1.—The mass of finely divided, low break up bubbles on emergence from passage exit.

which the new design permits. The standard of measurement here is the weight (in pounds) of distillate per pound of steam used; with the Weir Multiflash process values of eight and upwards are easily possible, using a smaller heating surface than had previously been necessary for a lower ratio (six) with the submerged tube design.

In the new process the important factor in economical operation has been found to be the end temperature difference in the heat exchangers which, for a given performance ratio, is continually improved as the number of stages advances. A good base for comparison is one having a performance ratio of three and requiring a heating surface of 0·138 sq ft per lb/hr of distillate. Retaining the same performance ratio (three) but using eight stages, the heating surface value per pound per hour falls to 0·117 sq ft, and with 20 stages to 0·1 sq ft per lb/hr, giving a saving of 38% in the heating surface value by the simple expedient of increasing the number

of stages. The greater number of divisions which this necessitates in the equipment naturally runs up the structural cost somewhat, but at the same time savings are effected elsewhere which more than compensate. As performance ratios rise, so also do the benefits as the table below shows:

Performance ratio	6		8	
No. of stages	8	20	10	20
Heating surface, sq ft per lb/hr	0·346	0·224	0·501	0·318

By increasing the number of stages it becomes possible to split the total temperature drop into a large number of successive drops, thus keeping the drop at any single stage quite small, and avoiding the use of sprays—with risk of carryover water and consequent reduction in purity of the converted water supplies—which otherwise are found necessary. But the designer must provide some alternative to ensure sufficient interface surface for flashing to take place, and in the Multiflash design the difficulty has been overcome by leading the brine flow into the flash chamber near the top, whence it falls substantially in a sheet and lands on a tray from which it is cascaded, again in sheet form, on to another tray or on to collected brine in the base of the chamber.

If the flow is to be by gravity the several chambers which function as stages must be in descending formation if in each the inflow is to be located at the top, but this adds constructional problems besides increasing costs, and a little reflection will suffice to indicate that from a constructional viewpoint all flash chambers must be on the same level. With so small a pressure drop between successive chambers the difference in the static head does not give much lift of the brine in its passage from one chamber to the next, but the successful solution to the problem was achieved by skilfully designing the flow passages between adjacent stages, the aim being to cause the vapour to commence flashing as the brine starts its ascent from the base of one flash chamber to the upper region of the next *en route*. The formation of vapour by flashing has been found to allow just that difference in density which is necessary to secure a substantial addition to the height. As the flow emerges at the exit of the passages a mass of finely-divided bubbles develops with relatively little break-up, yet such as offers a large surface for vapour flashing—the ideal condition. A good illustration of the fluid at the precise instant of emergence is given in Fig. 1.

Other technical points relate to the reduction of scale and the minimizing of corrosion risks, the methods used by the designers being possibly better understood by reference to the flow diagram seen in Fig. 2. In this particular diagram the sea water feed to the plant combined with surplus cooling sea water flows through the primary heat exchangers. The surplus cooling water is then rejected and chemical treatment for the reduction or prevention of scale formation is injected to the feed at this point. The feed then passes through sections of all the other heat exchangers. At exit from the last it has reached a temperature which is sufficiently high to give good thermal economy but low enough when combined with the appropriate chemical treatment to ensure that the rate of scale formation in these heater sections is very low. The feed then passes to a submerged tube heated vessel into which it is sprayed. In this vessel, it is de-aerated and also a large portion of the potentially scale-forming release of CO_2 takes place together with the precipitation of sludge. The steam supply to the submerged tubes of this deaerator represents one source of external heat supply to the plant. When the feed leaves

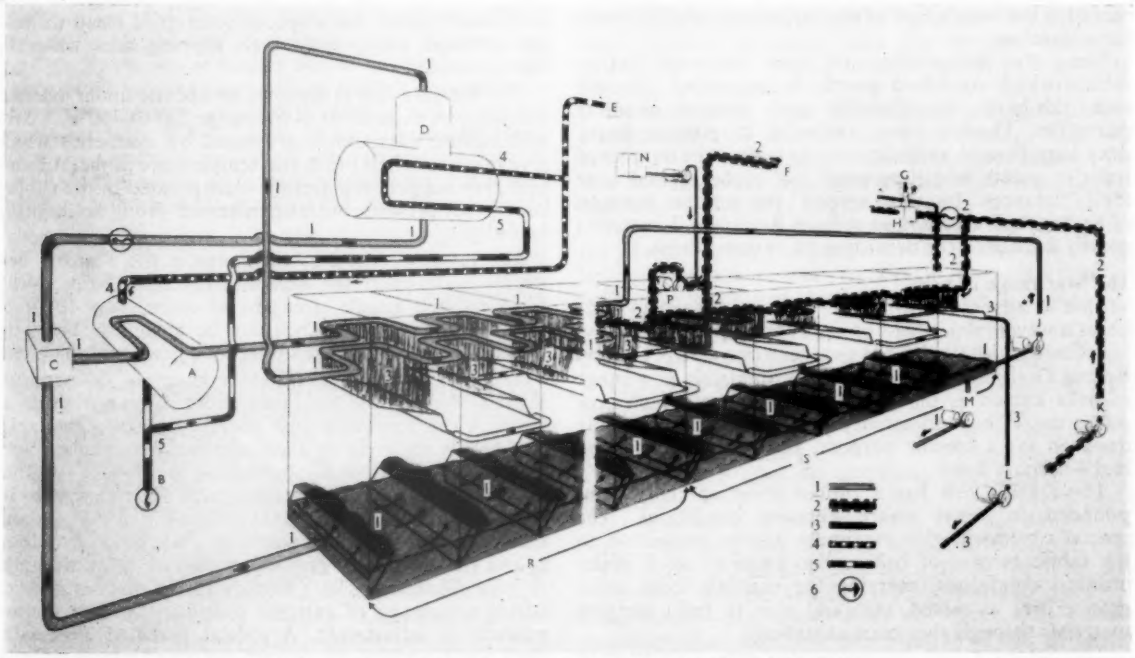


Fig. 2.—Flow arrangement of Weir Multiflash evaporating and distilling plant. A, external steam heater; B, drains to boiler circuit; C, mixing chamber; D, de-aerator; E, external steam supply; F, sea water discharge; G, steam to air ejector; H, air ejector; J, recirculating pump; K, sea water feed pump; L, distillate pump; M, brine pump; N, chemical injection unit; P, booster pump; R, secondary section; S, primary section

G. & J. Weir, Limited

Key:
1, brine, hot; 2, brine, cold; 3, fresh water; 4, steam; 5, drains; 6, pump

this vessel, it mixes with the recirculation which has been brought up to an appropriate temperature by passing through the main heater sections as shown, and also through a heater supplied with external steam—the other source of external heat supply to the plant. The mixed feed and recirculation now flows to the flash chambers where the repetitive flash process takes place. The condensation of the flashed fraction in each stage provides the preheat for the feed and recirculation. After the end flash chamber, blow-down to maintain the desired concentration occurs, and the remainder is recirculated.

In this process deaeration of the brine is effected while *en route* to the flash chambers, and with the CO_2 content very much reduced the risk of corrosion is lessened appreciably, The main heater-section tubes are fed with this recirculated brine, scale formation being retarded both by the previous scrubbing and precipitation from the feed and by the low concentration and high pressure of the recirculated brine.

The recent placing of a contract by the Guernsey Water Board for a 500,000 gal per day installation is a definite testimonial to the confidence held by independent experts as to the ability of the Multiflash process to supply the volume of water required. The people of that island are entirely dependent on a sure supply of fresh water for their fruit and flower industries as well as their personal requirements, and though rain supplies normally are adequate, the issues with which the inhabitants would be faced in the event of drought are too serious to trifle with. As regards costs, the Guernsey Authorities have satisfied themselves that the installation ordered—for delivery into service early in 1960—will prove cheaper than would the building of reservoirs and catchment areas. Costs would naturally be reduced still further in those schemes combining a Multiflash equipment with a modern electricity generating plant, and figures are available which demonstrate a surprisingly low cost for water *and* electricity when produced in combination.

Some Recent Developments in Conveyor Belting

Greater need for special purpose belting rather than reliance on multi-purpose belting has prompted the introduction of the Dunlop Star range

THE development of industrial rubber belting—now a highly important part of the Dunlop organization is backed by the earlier experiences of the Charles Macintosh Group whose belting production interests they acquired in 1926. For many years Dunlop belting production was housed in Manchester, but at the end of the war in 1945, future expansion in the demand for belting was visualized and the plant was transferred to Speke near Liverpool—a move which provided ample space for the installation of new equipment and left room for expansion.

Since the introduction of their patented Extron fabrics which combined greatly increased belt strength with flexibility, troughability and general handling properties, Dunlop have continued to pioneer heavy duty long belts in an endeavour to reduce the number of transfer points where material has to be carried over long distances. In this respect the unique position of having their own cotton mills at Rochdale, Lancs, has greatly facilitated the development of new fabrics.

The Star range of belts

With the advent of synthetic rubbers and man-made fibres an even wider field of application for the conveying of materials by belts, has now been opened up. Dunlop Belting Division has introduced a completely new range of belts known as the Dunlop Star Range, which now offers users the opportunity of using a belt specially designed for a specific purpose, rather than relying on multi-purpose belts.

The Starlife belt has a rubber cover specially compounded to resist severe abrasive conditions. The special cover will give maximum known protection to the fabric carcase of belts called upon to work under arduous conditions, carrying for example, cold coke, granite ores as mined, etc., and also to belts carrying materials through shot blast chambers.

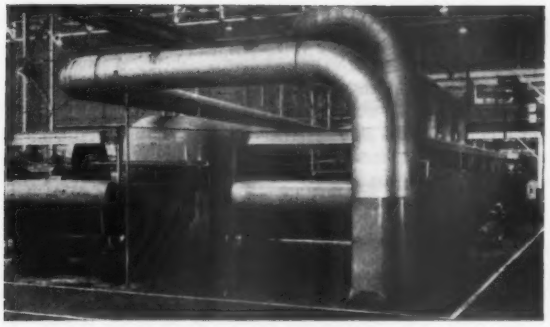
The Starwear belt incorporates a new Dunlop high strength fabric of 41 oz. weight. In its three-ply form one of these belts is claimed equal in strength to a six-ply belt of 32 oz. conventional cotton duck. This means smaller terminal pulley diameters with consequent reduced installation costs and lower power consumption. In addition to its exceptional tensile strength the belt has a high resistance to damage by impact, tearing, and damage propagation.

For conveying parcels, sacks, boxes, tins and unit loads of many kinds between floors of a building, or steep inclines of any kind, the Stargrip belting has been introduced which has a specially designed tread to hold the packages and prevent them slipping back when the belt is inclined.

The Starhete belt is designed to operate under extreme temperature conditions in the range 250 to 350°F. Cover and carcase compounds are based on synthetics which give maximum belt life in this temperature range. A flame and glow suppressing agent is incorporated in the rubber covers to prevent burning material from setting the belt alight.

The latest addition to the range is the Starfort belt which is designed for exceptionally long hauls. With this new belt tensile strengths of more than 10 times that of a conventional belt can be achieved. The construction of the belt is the subject of a new Dunlop patent.

The most recent Dunlop innovation, a patented segmental conveyor belt, now in an advanced stage of development and trial, will shortly be made available. The belt is made up in short sections or segments with close fitting castellated interlocking joints held together by a flexible tie-rod. All tension cords are arranged to be in one plane giving flexibility round the pulleys and their ends are moulded into the castellations to loop round the tie rod to provide maximum joint strength. A joint efficiency of 98% is claimed for this design with added advantage of extreme simplicity of belt section renewal or adjustment. A special patented process is used which enables the correct degree of lateral stiffness to be strictly controlled, thus the belt can be made suitable for a wide range of applications.



A line of spreaders which apply P.V.C. paste to the plies

Pressing P.V.C. belting in the Spooner Rotocure

As well as producing the new range Dunlops continue to manufacture their standard range of belts in accordance with B.S. 490 in vast quantities along with special belts of varying types to meet customers' requirements. Of these a revolutionary type of conveyor, patented by Cable Belt Limited, Inverness, is particularly noteworthy. The conveyor is essentially a rubber platform stiffened internally with ¼ in. square steel bars laid laterally at 4 in. pitch. The edges of the belt are of special grooved section to suit the two wire ropes upon which the belt will be carried. The use of the wire cables to take the pull instead of the belt itself offers many advantages; one cable belt conveyor will replace several flights of conventional belting, transfer points and accompanying material degradation thus being eliminated.

Manufacture of P.V.C. belting

The production of P.V.C. conveyor belting at Speke is largely a continuous process, brought about by the installation of a Spooner Rotocure Unit for curing the prepared plies. Untreated white duck from the Rochdale mills is first dried preparatory to the application of the P.V.C. paste. The paste is prepared by mixing P.V.C. polymers, plasticizers, stabilizers and pigment and grinding by the use of Muller wheels to ensure thorough dispersion. From the mixing plant which is mounted on a staging, the paste is pumped to storage tanks over the spreaders. Here P.V.C. paste is applied to the fabric which is accurately tensioned with an automatic electronic tension device. Tachometers ensure that the correct speed is maintained, an essential requirement in order to maintain the correct heat transfer.

A hot air dryer with automatic humidity control is used to dry the fabric to a pre-set humidity. This is important with certain ducks as the strength deteriorates if it becomes too dry.

A number of rolls of P.V.C. coated fabric, depending on the number of plies required in the finished belt, are fed into the automatic pre-set tension rollers of the Spooner-Rotocure plant to ensure that all plies are processed under the same tension. This particular machine built by Spooner Dryer & Engineering Company Limited, Ilkley, Yorks, will accommodate a maximum of 7 plies and produce finished belting 60 in. wide at the rate of 3 fpm. The rollers are adjustable to give tensions from 0—5000 lb and special guides ensure correct line-up of the various plies to avoid wastage of material.

Full gelation of the P.V.C. compound takes place in a 60 ft long curing chamber which is oil-fired and thermostatically controlled to 195°C. The heated plies leaving the chamber are consolidated under heavy pressure before passing on to a trimming table to be split to the desired widths. The cut widths are edged on patented Dunlop edging units, a continuous operation employing P.V.C. edging material which is bonded to the edge of the plies.

Throughout all stages of manufacture quality control inspectors keep a constant check on quality. Each belt has its own quality control card which accompanies the belt through every stage and carries the entry of every operative in charge of its manufacture.

Well equipped laboratories provide every facility for the development of new products in rubber and plastic belting plus the routine testing on the quality of all belts passing through the works.

Extremely simple to adjust or renew the Dunlop segmental conveyor belt is made up of sections with close fitting castellated interlocking joints held together by a flexible tie-rod

Calculating Weights

TO THE EDITOR OF MECHANICAL WORLD

Sir,—How simple it is to calculate the weight of steel billets or slabs, once you know how.

The formula is W × T (inches) × 10 = weight of a 3-ft length in pounds.

For instance take the following examples of billets and slabs:

(1) 2 in. sq. 2 × 2 = 4 × 10 = 40 lb for 3 ft
(2) 5 in. sq. 5 × 5 = 25 × 10 = 250 lb for 3 ft
(3) 5 in. × 2 in. 5 × 2 = 10 × 10 = 100 lb for 3 ft
(4) 6 in. × 2 in. 6 × 2 = 12 × 10 = 120 lb for 3 ft

So simple—billets and slabs are never truly square or rectangular, therefore this method of calculation is reasonably accurate.

Harold Jackson.

Sheffield.

Welding the Hunterston Heat Exchangers

Equipment in a specially erected workshop on the site of the new station

THE 16 heat-exchanger vessels being fabricated on site at the Hunterston nuclear power station are cylindrical pressure-tight containers which, when erected, will be 73 ft 6 in. high and 19 ft 6 in. dia. They will weigh over 200 tons. Inside these shells will be banks of specially-finned boiler tubing comprising the economiser, evaporator and superheater sections of the unit.

The vessels are being fabricated on site at Hunterston by the Motherwell Bridge and Engineering Company Limited in a large, fully-equipped welding shop constructed for the purpose. Each vessel is built up from six strakes, plus a top and bottom head and a supporting skirt. Each strake is composed of three shaped plates, and all internal and external seams, longitudinal as well as circumferential, are welded automatically by a complete installation supplied by Quasi-Arc Limited. The station is being built by The General Electric Company Limited, with whom are associated Simon-Carves Limited, the Motherwell Bridge and Engineering Company Limited and Mowlems (Scotland) Limited.

The design of an automatic welding installation on this scale, especially when all welds have to be of the highest possible X-ray quality, has presented numerous problems, and special machines have been produced to meet these exacting requirements. Basically, the workshop area is divided into two bays, each serviced by an overhead 40-ton Goliath crane. Among the operations carried out in the first are the setting-up and tack-welding of the strakes and the top and bottom heads. The strakes are then moved to the second bay which has two parallel sets of rails running down its length. It is in this bay that the main automatic welding operations are performed. The longitudinal seams in the strakes are first welded with a traversing and swivelling welding boom, the largest of its kind in the world, each strake being supported on one of the 40-ton roller-beds. The strake then passes via turntables to the next set of rails for circumferential welding. For this purpose, a second and somewhat smaller traversing welding boom is used, running on a separate track alongside the roller-bed track. At the same time the swivelling boom, which runs on the first set of roller bed tracks, can be turned through 90° and also brought into use over the second set of rails.

As the cylindrical vessel is built up it is X-rayed at every stage, holes are machined and nozzles and branches fitted; the complete shell is stress-relieved and hydrostatically tested, and finally the assembly is treated in a clean conditions chamber and dry-sealed ready for erection.

All welding is carried out by the Unionmelt process, using a total of four Quasi-Arc multi-power D.S.H. welding heads, mounted on two traversing raise-lower booms, two heads to a boom. In this method of welding two wires are used, each operating independently, having its own power source, feed motor, voltage control and nozzle assembly. Both wires are fed into a common weld pool. The current and arc voltage can be adjusted separately for each wire, allowing great flexibility in adjusting weld shape and penetration to obtain the best results at maximum welding speeds. Current is supplied by two Quasi-Arc transformers in Scott connection giving a maximum total current of 2000 amp. Welding speeds obtained with the multi-power Unionmelt process can be more than twice those obtained with single wire welding.

Both booms traverse on rails, having a welding speed traverse controllable between six and 60 in. per minute, and a high-speed traverse of 20ft per minute for rapid positioning. Welding controls are provided at the welding head itself, governing all functions of both the boom and the traversing roller beds supporting the section being welded. The operator is accommodated either sitting or prone at the welding head, and each boom carries its own power unit.

The smaller of the two booms, intended for external welding, will normally operate at right angles to the axis of the section welded, running on rails parallel to the roller bed rails. The other boom, in order to give the whole installation maximum flexibility, travels on the same rails as the roller beds and is arranged to swivel through 360°; it can perform both internal and external welds, the maximum length of internal weld being approximately 22 ft. External welds on vessels of somewhat over 20 ft dia can be performed with both booms. Again, for purposes of flexibility, remote control of all manœuvring operations, but not of welding conditions, is provided on the bogie of each boom. Ten roller-bed units are provided in the installation, each of which can support up to 40 tons, with a maximum of 20 tons/foot eccentric loading. Vessels with a maximum diameter of slightly more than 20 ft can be accommodated. All ten units are drive units for both rotation and traverse; in the case of rotation, driving power is applied to both sides of the bed. The roller beds are arranged with welding speed traverse facilities in case conditions should require stationary operation of the boom at any time.

The vessels to be welded are supported on special rubber-tyred wheels to ensure good grip and even load distribution. The carriage supporting the pairs of rolls incorporates special pre-loaded rollers (which are the subject of a patent application) to enable them to be easily moved to accommodate vessels of different diameters when the bed is unloaded. Each roller bed can be operated as a separate unit, or any number can be ganged together and will then operate as a single unit. Power supply for rotation and traverse of the roller beds is variable d.c. supply obtained from a.c. via a grid-controlled Thyratron circuit. This arrangement facilitates ganging, which can be carried out simply by connecting a plug on one bed to a socket on the next. Each roller bed has a safety trip switch in case of overload; when a number of beds are ganged together, operation of the trip in one of them will stop the whole gang, but an indicator light will tell the operator which bed has the fault.

An unusual feature of this site welding shop is the transportation bogies supplied as an integral part of the installation. After welding and radiographic examination is completed, the heat-exchanger vessels will be loaded on to a set of four bogies. They will then be transported to the stress-relieving area, where they will be given a 4-in. heat-insulating lagging. Hot gases will then be passed through the vessel for purposes of stress relieving. During this process the bogies will be water-

cooled. The vessels will then be filled with water for pressure testing. The weight of a vessel when filled with water will be approximately 1200 tons; under this load, the weight is not supported on the wheels of the bogie, but on special supporting pads. A rubber mounting between the support cradle and the track wheel frame ensures equal load distribution. When carrying loads of up to 300 tons, the bogies can readily be moved by any convenient means such as a capstan or tractor.

Ceramic to Metal Seals

Originally developed to overcome the limits imposed upon radio valve performance by the use of conventional glass to metal seals, Ferranti ceramic to metal seals are now widely used in the chemical and atomic energy industries as terminals for vacuum and pressure vessels operating at elevated and sub-normal temperatures.

This development stemmed from the requirements of the atomic energy industry for a considerable increase in the standard of reliability of seals for use as terminals in equipment such as atomic particle detectors, etc. Ceramic to metal seals were found to provide a solution to this problem, particularly as alumina ceramic has a low neutron capture cross-section, and as the materials used in the seals are for the most part compatible with liquid alkali metals, magnesium alloys, graphite, etc. Moreover, alumina type ceramics are ideally suited to vacuum and pressure vessel applications on the grounds of mechanical strength, low thermal shock and high melting point.

Unlike glass to metal seals which are made by actual fusion of the glass, requiring special precautions when accurate dimensioning is required, ceramic components can be conveniently ground to close tolerances. The nature of the sealing techniques gives further advantages when ceramic to metal seals are used. For example, above about 140° C for lead glass and 200° C for borosilicate glass, a d.c. voltage across a seal gives rise to glass electrolysis. This alters the structure of the glass at the seal giving an expansion mismatch, thus causing leakage and fracture, a phenomenon which has not yet been observed in ceramic to metal seals.

By using ceramic to metal seals, the radio valve engineer is able to make valves which he can bake out at temperatures of the order of 700° C—some 300° hotter than with glass—producing better vacua and consequently more efficient cathodes with longer lives. The valves can also be run hotter, are more robust and are dimensionally more accurate.

Although the technique of ceramic to metal sealing was first brought into production status by Germany during World War II, because of the shortage of glass, it is only in recent years that many of the technical problems affecting the practical applications of this technique have been overcome.

A considerable amount of work has been done in this direction by Ferranti Limited, who, in 1955, initiated a research programme to investigate the possibilities of ceramic to metal seals being used to replace the more conventional glass to metal seals, and to overcome some of their limitations.

As a result of this investigation, a wide variety of disc, compression and butt type seals, are now available for such diverse purposes as microwave and ordinary valve envelopes, semi-conductor envelopes, terminations for single and multicore cables and as thermocouple seals for furnaces. Metal parts of seals are in the form of tubes on the outside of ceramics.

Ferranti manufacture seals from 1 in. up to 4 in. dia, the last of these being under development, ready for assembly into equipment, mounted by any argon-arc welding, E.C.H. brazing or torch brazing.

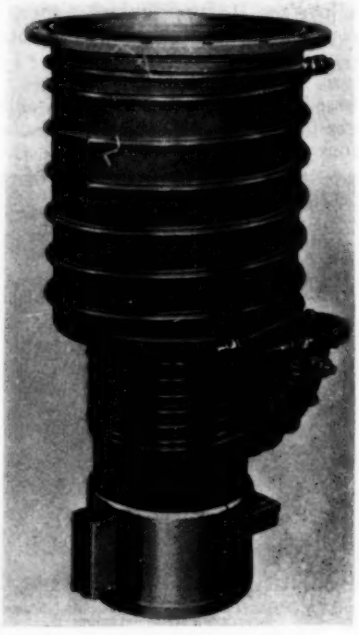
Recent investigations show that it is possible to make vacuum tight seals to pure alumina at a brazing temperature of 1250°C, which should satisfy the valve engineers' requirements of the highest possible bake-out temperature coupled with inert pure oxide ceramic material.

Argonarc Welded Dido Tank at Harwell

The Dido reactor core and heavy-water reflector at Harwell are contained in an aluminium tank made by the A.P.V. Company Limited. This is welded from 99·8% pure aluminium by the British Oxygen Argonaut and Argonarc processes. It has a number of nozzles for coolant inlets and outlets as well as thimbles for experimental holes and the 'false-bottom' plenum chamber and represented a complex task since welding had to be carried out to exacting standards, one of which was the necessity of identical analysis of the weld metal and the parent metal.

During manufacture, the vessel was fitted with support legs for the welding of the coolant pipes. These legs were afterwards removed and the vessel was supported by its top flange.

There are three inlets for the heavy water leading to the manifold or plenum chamber into which the fuel elements are fitted. In addition, there are four outlets which take the form of bell-mouthed weir pipes situated at about the level of the outlet ports from the fuel elements, i.e., approximately 30 in. below the normal level of the heavy water, this upper layer acting as a reflector and having a considerable effect on the reactivity. Heavy water entering the chamber at the bottom of the tank flows through the spaces between the fuel element plates, out of the fuel element ports and through the 7 in. weir pipes to a common header, feeding the pumps through Saunders valves.



ZETA'S DIFFUSION PUMP.—A design which formed the basis of the high vacuum system supplied by Metropolitan-Vickers Electrical Company Limited, Trafford Park, Manchester 17, for the Zeta torus, has been introduced as the Metrovac type 9/14. Designed primarily to give its highest pumping speeds at the lower pressures it is suitable for large vacuum systems used in nuclear research. The characteristics are those of a 14 in. dia pump at pressures below 5×10^{-4} mm Hg. and of a 9 in. dia pump at pressures of 10^{-5} mm Hg. but with a power consumption of only 2·5 kW for the oil and 3 kW for the mercury version of the pump

Forging Light Alloys

A LARGE Becker and Van Hullen press in the Dornier Works, Germany, was confiscated after the war by the Dutch Government as war reparations, and was acquired by the firm of Van der Heist and Zonen, of the Hague, for the pressing of automobile body parts. Recently it has been extensively rebuilt according to recommendations made by the Loewy Engineering Company Limited, and has been installed in the Birmingham Works of the Northern Aluminium Company Limited for the production of hand forgings and for closed-die and no-draft forgings and for the pre-working of cast stock prior to rolling and extrusion in the company's works at Banbury and Rogerstone.

In its original form, the 4000-ton hydraulic press was too high for Northern Aluminium Company's forging bay, the method of retracting the ram being by two cylinders mounted at the top of the press; the main alteration has therefore been the replacement of these by two push-back cylinders, reducing the height to 27 ft.

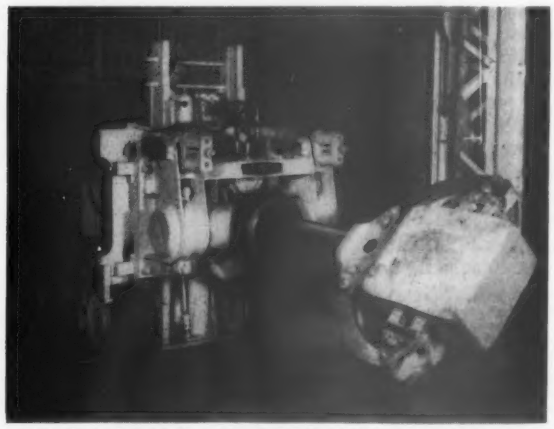
The press is fitted with ejector gear which takes the form of a 24-in. dia ram housed in a foundation 17 ft deep. From the bed plate rise the four main columns, 16 in. dia, surmounting which is the top crosshead. Below this is secured the main ram, 53 in. dia, on which the main cylinder, with the bolster secured to its lower face, moves up and down. Because of this principle of operation the main cylinder has guides at its top and bottom giving very accurate alignment between the upper and lower platens. The working space between the columns is 7 ft and the press has a stroke of 6 ft, giving 9 ft 1 in. of daylight between top and bottom platens.

Operation of the press is by means of a modern system of fingertip control through electro-hydraulic valves with a range of speeds varying from 0·08 to 0·50 in. per sec. This variation in speed is achieved by the selective use of twelve Fraser mono-radial pumps each driven by a 50 hp motor capable of delivering oil to the press at a rate of 20 gpm. To lower the cylinder, oil is passed into it from a 2500 gal refill tank under an air pressure of about 50 psi; when contact is made with the work the prefill valve closes and the pumps take over, delivering oil direct to the press at a total pressure of 4000 psi.

4,000-ton hydraulic press and some large hand forgings produced for an aircraft prototype, the largest weighing 1500 lb

The press was originally laid down to increase the scope of the hand forgings that could be offered by the company, especially for use in the aircraft industry, and among those already produced are several weighing 1500 lb each. However, used in conjunction with the 45,000 lb hammer already installed, it will also enable the company to offer bigger closed-die forgings, up to about 700 lb in weight, and it has already proved its usefulness in enabling cast stock to be pre-worked more economically, and in bigger sizes, than hitherto.

The handling of such large sizes during hand forging would clearly be impossible by the usual method, namely suspension from an overhead crane and manipulation by tongs. A mechanical manipulator has therefore been brought into use which is essentially a hydraulically-operated arm incorporating a means of gripping the stock, mounted on a fork-lift truck. The actual manipulating mechanism, which is of Salem Brosius design made under licence by Head Wrightson & Co. Limited and styled a "Manipulet", has a capacity of 1500 lb. It has great flexibility of movement, enabling the stock to be hoisted, lowered, tilted, moved from side to side and rotated through 360°, without the truck having to be moved. Of Yale and Towne design, the truck itself has a capacity of 10,000 lb which includes the power required to operate the hydraulic system of the Manipulet.



Stock for forging is handled by this mechanical manipulator which takes the form of a hydraulically-operated arm mounted on a fork-lift truck

Two-stroke Diesel-electric Locomotives for British Railways

IN our November issue* we described the first of a series of BB Type 2 1160 hp diesel-electric locomotives fitted with Sulzer engines and BTH electric equipment which had recently been completed for service in British Railways, Southern, Eastern and London Midland Regions. Another addition to the locomotive stock under the large scale modernization plan will be twenty 1200 hp mixed traffic diesel-electric locomotives now being built by Metropolitan-Vickers Electrical Company, Manchester, for handling traffic in the Midland Division of the London Midland Region. These Type 2 locomotives have Co-Bo wheel arrangements and are fitted with Crossley HST Vee. 8 engines, mechanical parts manufactured by Metropolitan-Vickers—Beyer, Peacock Limited, Stockton-on-Tees and electrical equipment manufactured at the Metropolitan-Vickers works at Manchester and Sheffield.

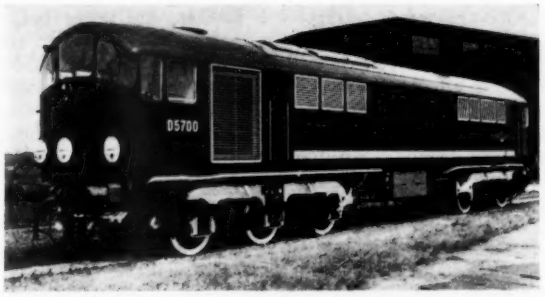
Power unit

The use of the Crossley diesel engine is worthy of comment as it is the only conventional engine of the two-stroke cycle type being supplied to British Railways and will provide them with a basis for comparing both two and four-stroke cycle types of diesel engine. The eight cylinders of 10.5 in. bore and 13.5 in. stroke are arranged in V-formation. It is continuously rated at 1200 hp 625 rpm and has a one-hour rating of 1320 hp at the same speed. Noted for its mechanical simplicity it represents the two-cycle engine in its simplest form, achieving a high power per cylinder without the complication of exhaust turbo-charging and the use of the port-controlled loop scavenge system eliminates the necessity for cylinder head valves or operating gear. The feature known as exhaust pulse pressure charging, which has been highly developed by Crossley Brothers, is also incorporated. By this means some of the scavenge air that has passed through the cylinder into the exhaust manifold is forced back into the cylinder by the exhaust pressure pulse from an adjacent cylinder; this occurs at the instant of port closure, thus creating a positive pressure of about 10 psi at the commencement of compression. A high efficiency scavenge blower of the three-lobe Roots type is built into the forward end of the engine and delivers air to the manifolds through a pair of water-cooled air-coolers.

The cylinder blocks are monobloc castings and are fitted with wet chromium-plated liners. The pistons are of the cast iron oil-cooled type, and the connecting rods have large end bearings of the tri-metal shell type which run side by side on a crankpin common to a cylinder pair.

Lubricating oil is supplied to the main bearings, the connecting rod large and small end bearings, the pistons, and other parts by a gear type pump chain-driven from an extension of the crankshaft. The engine has been further simplified by the use of electrically driven water pumps in place of the mechanically driven pumps used on earlier applications of this engine.

Cooling equipment comprises a pair of radiator panels mounted inside air ducting which connects openings in each body side to a motor driven axial-flow fan mounted in the roof. The engine-jacket cooling water temperature is kept close to the optimum figure by thermostatic control of the fan speed.



The first of twenty mixed traffic Co-Bo Type 2 diesel-electric locomotives built by Metropolitan-Vickers Company Limited

The main and auxiliary d.c. generators, are of integral construction. The frame is flange mounted on the end of the engine, and the armatures are mounted on a common hollow shaft, which is solid coupled to the engine crankshaft at one end and carried on a single roller bearing at the other.

The main generator supplies power to the five traction motors, the excitation being automatically controlled on eight of the ten master controller notches by the load regulator. It is an eight-pole machine with two separately excited field windings and a counter compounded series winding, which is also used when motoring from the battery for starting the engine. The continuous ratings are 750/475 volts, 1070/1650 amp 625 rpm.

The auxiliary generator is separately excited from the battery, and the output voltage is regulated to 110 V d.c. over the full range of engine working speed and load. It is rated at 110 V, 62 kW at 625/400 rpm.

Each of the five axles is fitted with an MV137BZ traction motor, which is a four-pole series-wound machine of the nose suspended axle-hung type. The motor is supported on the axle by two white-metal lined sleeve bearings, and the resilient nose suspension consists of a Silentbloc bushed link between bogie transom and motor frame. A similar link placed laterally between the bogie side frame, and the motor frame prevents "slide slog" of the motor on the axle and thus maintains the good riding qualities of the locomotive, with consequent reduction in wear and tear on the track.

The drive to the axle is through totally-enclosed single-reduction spur tooth gears with a ratio of 15:67, the gearwheel having torsional resilience between hub and rim. Provision is made for removal of the pinion from the armature shaft by oil injection.

The motors are force ventilated with cooling air from the traction motor blowers in the locomotive body, which deliver the air via ducting in the underframe and flexible rubber bellows between the underframe and the motors. Their continuous rating is 475 V, 330 amp, 180 hp, 510 rpm with 1250 cfm ventilating air.

Underframe and body

The underframe, carlines, cantrail, floor and body sheeting form a complete welded structure designed to give maximum strength with minimum material. A special feature is the incorporation of the main fuel and boiler water tanks within the underframe top and bottom plating.

Both three-axle and two-axle bogies incorporate one-piece cast steel frames of the General Steel Castings Corporation type. Orthodox body swing bolster suspension is adopted, the flat body centre pivot fitting into a

*"BR Type 2 Diesel-electric locomotives", *Mechanical World*, November, 1958, pp. 494-497.

Ferobestos lined cup on the bolster, the latter being hung from the frame by swing links, of which there are eight on the three-axle and four on the two-axle bogies. Tractive effort and braking forces are exerted through renewable liners placed between the bogie transoms and the bolster. Springing is by the semi-equalizing method, whereby beams span the distance between the axles, and the bogie frame is supported on helical springs resting on these beams.

All wheels have clasp brakes, operated through equalized brake rigging by three cylinders on the three-axle bogie and two cylinders on the two-axle bogie.

Auxiliary equipment

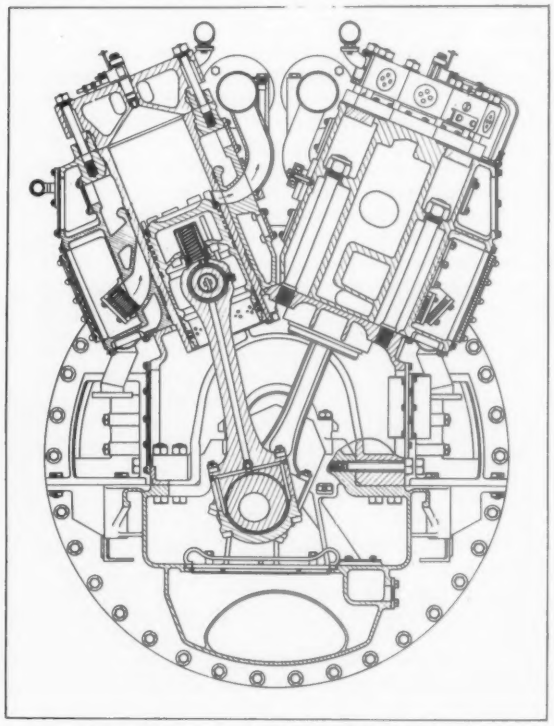
Compressed air, for operation of the locomotive brakes, electro-pneumatic control gear, window wipers and sanding gear, is supplied by an engine-driven Worthington-Simpson compressor, type VL 79S. Two of the Westinghouse type 4V110G vacuum exhausters are also provided for operation of the brakes on vacuum fitted rolling stock. Two Keith Blackman fans supply cooling air to the traction motors in the bogie below. A Davidson steel plate axial-flow fan mounted in a fan chamber in the generator compartment, pressurizes the latter for the purpose of force-cooling the generator.

Steam supply to the train heating system is generated by a Spanner oil-fired fire tube boiler having a capacity of 1500 lb of steam per hr.

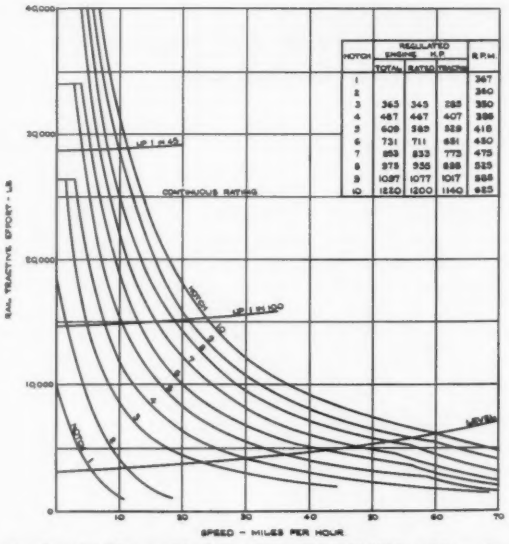
Control equipment

The main generator supplies the five motors which are connected permanently in parallel and each motor circuit has an electropneumatic contactor and an overload relay. A single electropneumatic drum-type reverser is used to reverse the motor field connections.

The master controller provides the driver with the means of selecting the direction of travel and the power



Cross section of the Crossley HST Vee. 8 Diesel engine



Tractive effort/speed diagram. Maximum tractive effort is 50,000 lb, and the continuous tractive effort is 25,000 lb. On notch 10 full power is available between 4·3 and 61 mph, by control of generator excitation up to about 25 mph and by traction motor field weakening thereafter, and the equipment is within the continuous rating at all speeds from 13·5 mph to 75 mph. At speeds below the full power range the tractive effort is automatically limited to the maximum by a current limit relay

at which the engine shall work. It is interlocked with a key removable only in the "off" position. The selector handle has four positions, viz, forward, off, engine only and reverse, the handle being in the "engine only" position when starting the Diesel engine. The power wheel has ten notches to provide increments of engine power up to the maximum of 1200 hp on notch 10. The use of the notch or stepped system of control eliminates the need for additional flexible air connections between locomotives when operating in multiple, and also ensures correct load sharing at all times.

In notches 1 and 2 the engine runs at its idling speed, and the main generator is excited by the two stages of primary field strength. From notch 3 (corresponding to about 25% traction horsepower) to notch 10 (full load) the engine speed and bmep are automatically set (by the engine speed regulator) to give increments of power, and this ensures that the engine operates at optimum conditions. Thereafter, adjustment of the electrical load to maintain the chosen conditions irrespective of track speed and train load is by the automatic load regulating apparatus. This comprises a servo mechanism in which a hydraulic pilot valve, connected to the engine governor fuel lever, actuates a servo motor when displaced from the neutral position.

The locomotive is braked by the Metcalfe-Oerlikon vacuum-controlled direct air brake system, the equipment being manufactured by Davies & Metcalfe, Limited.

Leading particulars

Wheel arrangement	Co-Bo
Total weight in working order	97 tons
Length overall	56 ft 7½ in.
Total wheelbase	42 ft 7 in.
Bogie wheelbase	12 ft 1½ in. (Co) and 8 ft 6 in (Bo)
Distance between pivot centres	32 ft 4 in.
Width overall	9 ft 2½ in.
Height overall	12 ft 8¾ in.
Wheel diameter	39½ in.
Type of bogie	Cast steel with swing bolster
Traction motor gear ratio	15:67
Crossley HSTVee 8 diesel engine continuously rated hp	1200 hp at 625 rpm
Maximum tractive effort at rail	50,000 lb.
Continuous tractive effort at rail	25,000 lb at 13.5 mph.
Maximum service speed	75 mph.
Minimum curve radius	3½ chains.
Fuel oil capacity (engine and boiler)	510 gall
Water capacity for boiler	600 gall

BICERA Handbook on Torsional Vibration. Compiled by E. J. Nestorides. London, 1958; Cambridge University Press. 110/- net (by post 111/9). 664 pp. 6×9 in.

The moving parts of an engine and its auxiliaries form a complicated system and before its vibration conditions can be investigated it is necessary to replace the system by an equivalent arrangement of concentrated masses. This is done by determining the polar mass moments of inertia of the various parts of the engine, calculating the stiffness and finding their equivalents. This information is then used in a number of methods for determining the natural frequencies. The next step is to evaluate the stresses set up by torsional vibration and in design to predict the vibration amplitudes as well. This involves considering the variations of gas pressure in the cylinder and variations in the inertia of the moving parts, and taking into account the machinery to which the engine is coupled: in connexion with this work the designer has recourse to the recommendations, rules and guidance rates issued by the various classification societies, and is concerned also with the design of various devices which can be embodied in the engine for limiting vibrations. All these matters are dealt with very fully in this handbook, which is very much a "how to do it" text and, therefore, a particularly useful one for both designer and development engineer, and more particularly so in view of its unquestionably authoritative source. For the designer it provides formulae, graphical procedures, numerical examples and tabulated values; and for the development engineer, detailed descriptions of test procedures, rigs and instrumentation. It stems from work in the BICERA laboratories and from the practice of the British internal combustion engine makers, and must undoubtedly be ranked among the major key texts in its subject.

The Pump Users' Handbook. By Herbert Addison. London, 1958; Sir Isaac Pitman & Sons Limited. 30/- net (by post 30/8). 122 pp. 5½×8½ in.

How to choose a pump, how to install it, how to run and maintain it, how to diagnose its troubles if it has any, how to judge its performance, how to test it, and how to guard against cavitation and pressure surge—these are the questions the pump user asks himself and which he will find answered by an eminent authority in this book. Sponsored by the British Pump Manufacturers' Association, it supplements and does not replace each maker's specialized literature. It is the common ground among all of them with which the pump user must be familiar if he is to get the pump most suited to his needs—and the range from which he must select grows almost daily in the present environment of rapid technological advance. The handbook includes selection charts based on possible types of machine and also a supplement which gives guidance in finding the names of makers likely to be able to supply the type of pump indicated.

books

The Heat Treatment of Steel. By Edwin Gregory and Eric N. Simons. London, 1958; Sir Isaac Pitman & Sons Limited. 35/- net (by post 36/3). 381 pp. 5½ × 8½ in.

This book first appeared in 1944 and it was reprinted three times before the end of 1947. It is a second edition which now appears, and in it the scheme has been completely altered and the text has been amended and augmented to take into account the research and development which has taken place in the intervening years. The book now opens with a discussion of principles and then goes on to processes, furnaces, temperature measurements, quenching media and equipment, and then to heat treatment practice at length. Finally, certain specialized topics like cyaniding and nitriding and induction heating, are described. The treatments to be given to various carbon and alloy steels, both cast and wrought, are detailed, and also the treatments for springs, gears, magnets, dies, moulds, hobs, and heat resisting steels. Furnaces and pyrometers receive equally full attention.

There are many other points of detail which could be mentioned to illustrate how the text has been brought up to date, but it will perhaps suffice to say that it is both comprehensive and detailed and of sufficient scope to make it a worthwhile addition to the technical reference shelf as well as for systematic study.

Transform Method in Linear System Analysis. By John A. Aseltine. New York, 1958; McGraw-Hill Book Company Inc. London; McGraw-Hill Publishing Company Limited. 66/- net (by post 67/3). 300 pp. 6 × 9 in.

The engineer uses mathematics to get results as quickly as possible; that is why he uses logarithms and the slide rule. With the help of mathematicians like Mr. Aseltine he can do something similar in the more advanced branches, and in this present book he is presented with a tool for using linear differential equations with very nearly the facility offered by algebraic manipulation, the medium being the Laplace transforms. The transforms are tabulated and once it is grasped how they are used to replace the terms in the equations it takes little more than substitution to get a result. The author explains how the technique is applied to problems in electricity and mechanics. He also introduces Fourier transforms, which he applies to problems concerning noise, and two other transforms, Z and Mellin, which he illustrates with examples. Throughout the work the author pursues the additional goal of using the transform method to give an understanding of physical phenomena.

Data on Materials.—The Materials Information Centre of Materials Data Limited, 273 Farnborough Road, Farnborough, Hants., has devised a very compact way of presenting a large volume of data. For example, in their publication "Materials Arranged in Order of Merit: Part I, Mainly Mechanical Properties", information is collated on 96 materials in the form of "merit indices" each of which combines several design factors. There appear to be forty merit indices with practical value, ranging from strength/weight to thermal conductivity/cost. These have been embodied in three publications: the first on mechanical properties as already mentioned, the second on thermal and electrical properties while the third contains mixed indices of thermal, electrical and mechanical ratios. These listed indices are of great value for rapid design selection. They have been calculated on an electronic computor and the three parts now issued are part of a broader survey which, together with other facilities, is available to those belonging to the Materials Data

Centre. The membership fee is seven guineas annually.

Crane Safety.—The report of the Accident Prevention Committee of the British Iron and Steel Federation, Steel House, Tothill Street, London SW1, on the subject of crane safety in the iron and steel industry is a model on how instruction on this kind of subject should be drawn up. It has evidently been drawn up by people who know the problems intimately and who have tackled them with scientific method. The result is a clear, practical text on both machinery and men—what to do with the one and how to select the other. Although directed to the steel industry the report will be of the greatest use to other crane users —particularly those who operate overhead and rail slewing cranes.

Accidents report.—In 1957 the total number of reported accidents in all premises subject to the Factories Acts, was 174,713, of which 651 were fatal. The corresponding figure for 1956 was 184,785 of which 687 were fatal. These figures represent a decrease of over 5% in all reported accidents. With this reduction in the total number of accidents there have been proportionate reductions in almost all the industry groups. The development of power driven lifting machinery in factories and on building sites and docks has increased and this is reflected in the total accident figures, which have risen, although the number of fatal accidents has declined. The number of accidents associated with other classes of power driven machinery shows a steady reduction. The figures for all industries and all kinds of accident are reported upon and analysed fully in the report of the Chief Inspector of Factories for 1957, available from H.M. Stationery Office, price 5/- net.

Chemical Engineering Teaching Laboratories.—The Institution of Chemical Engineers, 16 Belgrave Square, London, SW1, has published a new pamphlet entitled: "Notes on Laboratories for the Teaching of Chemical Engineering". It is almost ten years since the pamphlet "Equipment of Chemical Engineering Laboratories" was first published by the Institution. During this period the number of full-time courses in chemical engineering in the United Kingdom has more than doubled and much experience has been gained in the design and equipping of laboratories for them. Experience gained during this period of expansion is embodied in the new pamphlet which also takes into account suggestions and ideas put forward by teachers of chemical engineering.

"B.C.A.C."—The British Conference on Automation and Computation has commenced publication of the "B.C.A.C. Bulletin" which will list forthcoming meetings and reports such items as the activities of the International Federation of Automatic Control, and announce forthcoming international conferences etc. The Bulletin will be issued bi-monthly, price 1s. post free to members and 2s. to others. Requests should be sent to "B.C.A.C. Bulletin, c/o The Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, SW1".

Welding Aluminium.—Since the Northern Aluminium Company Limited, Banbury, Oxfordshire, first issued their book "Welding Aluminium" some three-and-a-half years ago, when the methods available for welding light alloys were not very widely known nor the characteristics of aluminium welded joints fully appreciated, great advances have been made both in technique and the amount and scope of work done. An extensively revised edition of the book has now been produced. As before, it deals almost exclusively with the two shrouded arc processes—"argon tungsten arc" and "inert metal arc"—and much of the space is taken up with tables of procedures. The information on processes has been brought up to date, a section added on welding technique, and the tables of procedures—still the most useful part of the book—have been entirely revised, with full explanatory notes and illustrations giving edge preparation and joint details. In addition an appendix has been added giving information on alloys and current ratings.

Advertising and Market Research.—This is the title of a pamphlet showing the resources of the Manchester Commercial Library on these subjects in the form of periodicals, statistical data, dictionaries, directories, annuals, readership surveys, consumer reports, marketing surveys and text books. The list is selective and should prove most useful both to advertising executives and their clients. Numbers 8 and 9 in the Library's European Economic Co-operation series of reading lists are also now available. Copies of these publications can be obtained from the Commercial Library, Central Library, Manchester 2. Telephone No. CENtral 7401. Telex 66-149.

Automatic Welding.—The British Welding Research Association, 29 Park Crescent, London W1, is undertaking the cover to cover translation from the Russian of "Avtomaticheskaya Svarka" (Automatic Welding) and will start with the January, 1959, number which is expected to arrive in Britain in March, and to be distributed in translation to subscribers in May or late April. The subscription price will be £10 10s. 0d. for the 12 issues of 1959.

Transistor bibliography.—Those of our readers who have had assistance from the ten-year bibliography on semi-conducting materials prepared by the Newmarket Transistor Company Limited, makers of Goltop transistors, Eyning Road, Newmarket, will be interested to learn that a new and much larger 15-year bibliography has now been published. It has been compiled by N. L. Meyrick of the company's research library.

Design for Welding.—A book of ideas for the efficient use of steel in machine design and manufacture has been published by The James F. Lincoln Arc Welding Foundation, Cleveland 17, Ohio, U.S.A., price $2·50 post free. It provdies a series of check lists and suggestions with which designers and production men can guide their efforts and contains a review of 73 welded designs of a wide variety of machines. The designs are classified according to the basic type of component and each illustrates several ideas with which lower costs and better performance have been obtained.

New Standard

Standard test finger (for checking protection against electric shock) (B.S. 3042:1958). Price 3/-.

A standard test finger is used to determine whether metal parts which might become electrically "alive" are adequately protected from human contact. Experience has shown that the present Standard is desirable to obviate repetition of detailed requirements for the device in the many other Standards where the test is needed. The publication is illustrated and gives the form and method of use of a test finger.

British Standards Institution, 2 Park Street London, W1.

BUSINESS & PROFESSIONAL

Personal

Mr. J. N. Toothill, C.B.E., has been appointed to the board of Ferranti Limited. Mr. Toothill joined Ferranti Limited in 1935 as chief cost accountant, and was appointed general manager of the Edinburgh Factory in 1942, which position he still holds.

GEORGE ANGUS & CO. LIMITED announce that **Col. E. G. Angus,** chairman and managing director since 1933, has retired as managing director, but continues as chairman. Col. Angus, one of Tyneside's best known industialists, is head of a group of companies which had their origin in a family business established in Newcastle in 1788. During his chairmanship, he has seen this group grow from a firm with 468 employees to its present size, with five plants in the U.K., one each in Canada and Italy, and employing over 3000 persons. Several changes in the senior management of the company came into effect on January 1, 1959: **Sir Walter J. Drummond** becomes an additional deputy chairman. The other deputy chairman is Mr. G. A. Sowerby. Two managing directors appointed in Col. Angus' place are: **Mr. D. Drummond Angus** managing director of the General Divisions (which covers all departments other than engineering divisions). A great-grandson of the founder of the company, he has been a director since 1929 and sales director since 1950. **Mr. A. Procter,** managing director, Engineering Divisions which embraces Oil Seal and Gear Divisions. Mr. Procter has been a director since 1953. **Mr. D. E. F. Canney,** a director of George Angus & Co. Limited since 1953 and managing director of Telamite Limited, becomes chairman of that company. He is also executive vice president of George Angus (Canada) Limited. **Mr. C. L. G. Baker** continues as secretary and financial controller. He was appointed a director last July,

Mr. R. A. Millar Craig, B.Sc., A.M.I.Mech.E., A.M.I.Chem.E., has been appointed general works manager for the new factory which is now under construction by Carbide Industries Limited at Maydown, Londonderry. Carbide Industries is a unit of the chemicals division of the British Oxygen Company.

C.A.V. LIMITED, Acton, London W3, announce the following further changes on the sales and service side: The eastern area has been enlarged and extends from Lincolnshire to Essex. **Mr. G. H. Wolno,** area manager, will now operate from Cambridge. The south-eastern area, (manager, **Mr. D. J. Thomas**) originally divided into North Thames and South Thames regions, is now reconstituted into an area comprising the Home Counties plus Hants., Sussex, Oxfordshire and Berkshire, with headquarters at Brighton, and a London area (manager, **Mr. J. E. Liardet**) comprising the Metropolitan Police District, an area of approximately 18 miles radius from Charing Cross, with headquarters at Acton.

FOLLOWING the death of the chairman of Howard Clayton-Wright Limited, **Mr. Graham Clayton-Wright,** formerly the technical director, now becomes chairman and managing director, and his place has been filled by the new appointment to the board of **Mr. R. R. Webb, A.M.I.Mech.E.,** previously chief of design.

WALKER & MARTIN LIMITED, of Bolton, announce that **Mr. H. Stromberg, M.Sc., F.R.I.C., A.M.I.Chem.E.,** joined their group on January 1,1959, as managing director of their chemicals division comprising Walker Extract & Chemical Company Limited, Bolton, and Arthur Ashworth Limited, Bury. Mr. Stromberg is relinquishing his position of director and chief engineer of Ashburton Chemical Works Limited (member of the Geigy Group of companies in Great Britain) in order to take up this appointment.

Sir Leslie Rowan, K.C.B., C.V.O., and **Mr. R. P. H. Yapp** (who is a director of Vickers-Armstrongs Limited) have been appointed to the board of Vickers Limited.

FIRTH CLEVELAND TOOLS LIMITED, Tipton, Staffs., a member of the Firth Cleveland Group, announce the appointment of **Mr. F. A. Field** as general sales manager. For many years Mr. Field held a similar position with Black & Decker Limited.

LANDMASTER LIMITED, Hucknall, Nottingham, a member of the Firth Cleveland Group, announce the appointment of **Mr. J. H. Smeddle** and **Mr. M. M. Monfort** as export executives. Mr. Smeddle has recently joined the organization from Harrison, Lister Engineering Company Limited, of Ceylon, and Mr. Monfort was previously European representative of Landmaster Limited. **Mr. T. Rennison,** formally shipping manager, has been appointed commercial manager (export).

RETIRING this month after a long association with the Brockhouse Organization is **Mr. A. Trevena,** works manager, of Thomas Chatwin & Company, manufacturers of engineers' tools. Mr. Trevena joined Chatwin's over 30 years ago and during the war he was concerned with many important projects. **Mr. E. S. Broxton,** a qualified metallurgist, who has been assistant works manager for several years, succeeds Mr. Trevena.

Major-General E. P. Readman, C.B.E., T.D., who recently retired from English Steel Corporation Limited, has joined the boards of Darwins Group Limited and Andrews Toledo Limited, The Sheffield Forge & Rolling Mills Company Limited and the other subsidiary companies of the group.

Mr. R. S. Simpson has been appointed manager of The North-West Region of The British Institute of Management to succeed **Mr. A. D. Ashley, M.B.E., T.D.** This region of The Institute, with the office in 235 Royal Exchange, Manchester, includes the branches in Blackburn, Manchester, the Merseyside branch in Liverpool and Warrington. Mr. Simpson has held the appointment of general manager of Samuel Gratrix Limited (Engineering Division) and other executive appointments in the engineering and aircraft industries. **Mr. H. Mc. N. T. Reith, M.A.,** has been appointed as manager for The Southern Region. This region of The Institute, with the office at Management House, London EC4, includes the branches in London, Luton, Norwich, Portsmouth, Slough, Southern and the Hants and Dorset branch in Southampton. Mr. Reith was formerly assistant group personnel officer with Fisons Limited, and has held positions at home and abroad in The Communications and Information Departments of H.M. Foreign Service and in The Inspection Departments of The Ministry of Supply.

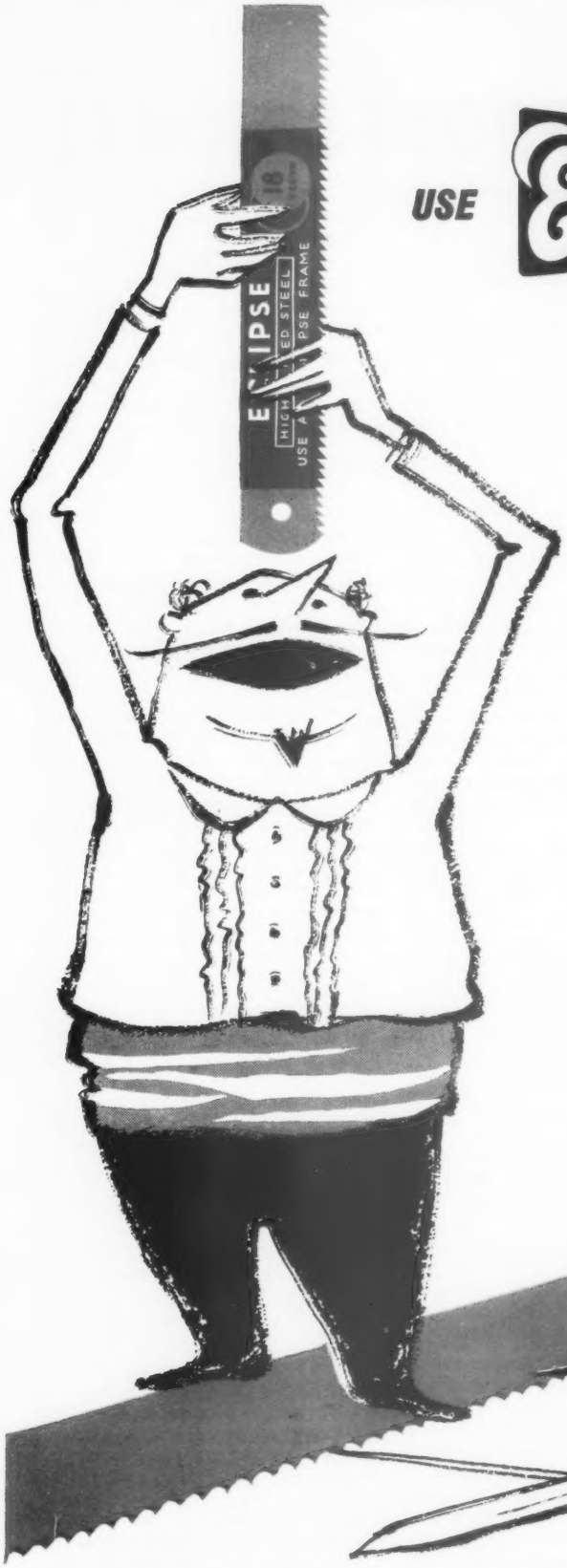
Mr. John Page has joined the staff of Dr. Allan C. Waine, research director of the Triplex Safety Glass Company Limited, at the firm's principal factory at King's Norton, Birmingham. Mr. Page, formerly a consultant with PERA of Melton Mowbray, will assist Dr. A. J. Holland, the firm's chief physicist, on all projects connected with safety glasses for the aircraft industry.

In view of the recent retirement of the director, **Dr. J. G. Pearce,** C.B.E., the British Cast Iron Research Association has made the following appointments from January 1, 1959. **Mr. H. Morrogh,** to be director; **Dr. H. T. Angus,** to be deputy director. **Mr. T. E. Whiteside, A.C.A.,** will continue as secretary with special financial duties.

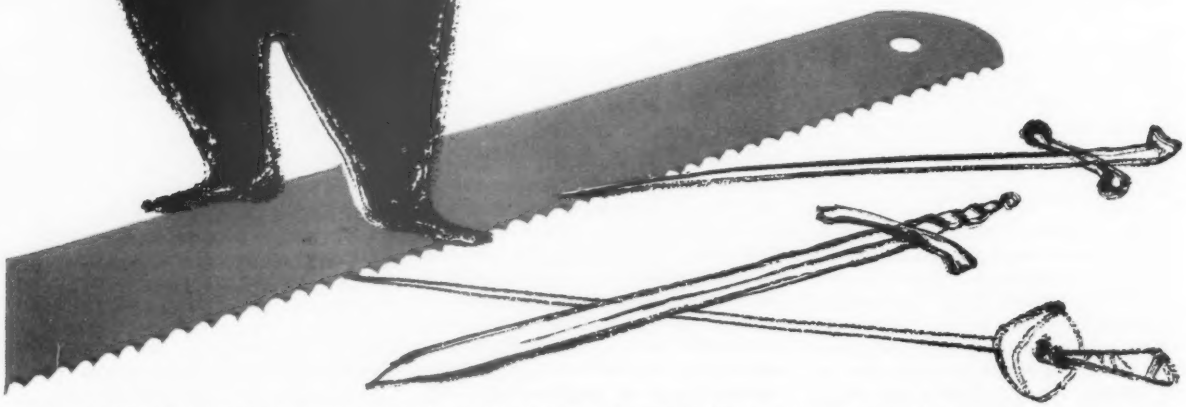
OWING to his other commitments in the Vickers Group, **Mr. A. H. Hird, A.C.G.I., B.Sc., M.I.Mech.E.,** has relinquished his seat on the board of directors of Vickers-Armstrongs (Engineers) Limited.

Mr. Harvey Raasch has been appointed managing director of Hyster Company's European manufacturing plant in Nijmegen, The Netherlands. **Mr. Frank Rostedt,** who

USE Eclipse HACKSAW BLADES



and feel the difference!



'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors

UH 26

has been managing director of the Nijmegen plant for the past five years, returns to the company's Peoria, Illinois, office as a vice-president in charge of the international division.

Mr. Duffin McNeice, 87 Rochester Avenue, Cregagh, Belfast (Belfast 48823) is now the sole representative for Dewrance & Company Limited, for Northern Ireland.

Mr. G. C. R. Eley, C.B.E., has joined the board of the British Oxygen Company Limited.

THE following members of the staff of Wolf Electric Tools Limited have been elected to the board of directors: **Mr. N. McCann,** secretary and director; **Mr. R. G. J. Nisbet,** director of Canadian operations; **Mr. J. A. Jackson,** works director; **Mr. W. N. Scottorn,** sales director.

Mr. R. W. Boyd has been appointed technical representative for Scotland for Coventry Gauge & Tool Co. Limited. Mr. Boyd was for several years assistant chief draughtsman at the company's Brechin, Angus factory.

THE appointment of **Mr. Arthur Griffiths, O.B.E., M.I.P.E.,** as group managing director of Sterling Industries Limited, the engineering group of Chard, Somerset, was announced recently.

THE appointment of **Mr. L. J. Dunnett, C.B., C.M.G.,** to be a deputy secretary in the Ministry of Transport and Civil Aviation was recently announced. Mr. Dunnett is now in charge of inland transport matters at the Ministry in place of **Mr. P. Faulkner** who has taken over shipping matters.

ON October 31, 1958, **Mr. J. W. Heathcote** retired from his position of purchasing manager of Ferodo Limited after 34 years' service with the company. Soon after Mr. Heathcote's arrival at Ferodo Limited in 1924 he formed the wages department and in 1927 took over the purchasing department, of which he has been the manager ever since.

Mr. David E. Burton, B.Sc.(Eng.), has been appointed to be in charge of the London technical sales department at Ibex House, Minories, E.C.3., of Rocol, Limited, Swillington, near Leeds, manufacturers of molybdenized and other industrial lubricants. Mr. Burton is a specialist in cutting lubricants and was previously assistant works manager to the Hanworth Engineering (Aircraft) Company Limited, Sunbury-on-Thames, Middlesex.

Mr. Kurt P. Källgren has been appointed by the Solartron Electronic Group Limited, Thames Ditton, Surrey, to manage their subsidiary company now being formed in Stockholm, Sweden.

Mr. A. W. A. Dick-Cleland, B.Sc., A.R.T.C., M.I.E.E., F.B.I.M., who recently relinquished his appointment as joint managing director of the Lancashire Dynamo and Crypto Limited, Trafford Park, Manchester, has been appointed a director of Brush Electrical Engineering Co. Limited, and the manager of their rotating machines division at Loughborough.

Mr. R. L. Watt has been appointed a director of The National Gas & Oil Engine Company Limited, and, whilst remaining director and general manager of Mirrlees, Bickerton & Day Limited, has been seconded to The National Gas & Oil Engine Company Limited, at Ashton-under-Lyne, as general manager. **Mr. D. Adamson,** works and planning manager of Mirrlees, Bickerton & Day has been appointed a director of The National Gas & Oil Engine Company and a local director of Mirrlees, Bickerton & Day. He has been seconded to The National Gas & Oil Engine Company as works director. **Mr. Frank Wood** has been seconded to Mirrlees, Bickerton & Day Limited as works manager.

METROPOLITAN-VICKERS ELECTRICAL Company Limited announce that recent engineering and commercial appointments include those of **Mr. C. F. Saunders, Assoc.M.C.T., A.M.I.E.E., M.Inst.W.,** formerly chief engineer, heating and welding department, as chief engineer, standards department; **Mr. G. H. Moule,** formerly assistant chief engineer (heating), heating and welding department, as chief engineer, heating and welding department; **Mr. R. F. Mansfield, A.M.I.E.E.,** as assistant sales manager, industrial control department; and **Mr. F. Crowther, Assoc.M.C.T., A.M.I.E.E., A.M.A.M.E.M.E.,** as assistant chief engineer (design), industrial control department; **Mr. R. Crummack, B.Eng.(Elec.),** as assistant superintendent, process and rate department; **Mr. R. G. Nicholas** as assistant superintendent, process and rate department (method study); **Mr. J. P. Stockbridge,** assistant superintendent, motor department; and **Mr. W. A. Ciclitira, B.Eng., A.M.I.E.E.,** assistant sales manager, motor department. A.E.I. Turbine-Generator Division: **Mr. J. Richmond** as divisional executive (Rugby) and sales manager (Rugby), succeeding **Mr. J. G. Boddy** who relinquished these positions in order to take up another appointment; **Mr. J. W. Ward** as assistant sales manager (Rugby); **Mr. D.R.S. Turner,** formerly manager (Larne Works), as divisional commercial manager, taking over the duties previously performed in that capacity by **Mr. R. J. Cochran** who is devoting full time to his position as divisional general manager; **Mr. R. R. Whyte,** formerly divisional manufacturing manager (Trafford Park), as divisional manufacturing manager, retaining his existing appointment as assistant works manager (mechanical), Trafford Park, **Mr. W. T. H. Golding** as works manager (Larne works); **Mr. R. O. Knight** as superintendent, Larne works. Earlier appointments not hitherto recorded include **Mr. H. I. Wood,** chief engineer, turbo-generator department, Trafford Park; **Mr. F. R. Harris,** chief engineer, gas turbine engineering department; **Mr. F. W. Craven,** superintendent, small turbine department; and **Mr. J. B. P. Wood,** assistant superintendent, small turbine department.

Mr. H. N. Wigan has resigned from the board of the Amber Chemical Company Limited. **Mr. J. Firminger,** who joined the company at the end of 1957, and was appointed general manager home sales, is now appointed technical manager. **Major-General E. P. Readman and Miss V. A. Pease** have joined the board of Amber Chemical Industries Limited. Major-General Readman has recently retired from the post of managing director of the English Steel Tool Corporation. Miss Pease has been for some time past a director of the Amber Chemical Company Limited and Charles H. Windschuegl Limited, component companies, of the Amber Group.

Mr. John Smith, J.P., A.M.C.T., M.I.Mech.E., A.M.I.Mar.E., has been appointed technical director of Petters Limited, Staines, Middlesex. He was previously technical director of the National Gas & Oil Engine Company Limited, Ashton-under-Lyne, which he joined in 1928.

Mr. M. H. Sayers, D.S.C., A.M.I.Mech.E., has been appointed apprentice training manager of F. Perkins Limited Peterborough. He succeeds **Mr. J. Talbot,** who is taking up an appointment outside the company.

PHILIPS ELECTRICAL LIMITED, announce the appointment of **Mr. Hector Thorne,** at present general regional manager, South-East Region, to be a personal assistant to the managing director, responsible for market development. **Mr. W. F. Cassidy,** at present regional manager, Midlands Region, to be general regional manager, South-East region. **Mr. D. E. Beard,** at present branch manager, Bristol, to be regional manager, Midlands region.

Mr. D. J. Taysom, A.M.I.Mech.E., has now been appointed managing director of the Cimex-Fraser Tuson company, manufacturers of industrial floor maintenance machines.

AN award of 100 gns. has been made by The Plessey Company Limited to one of their employees—**Mr. F. J. Hancock** of Romford, who works in the radio and

RAWLBOLTS

for SPEED

STRENGTH

SECURITY

NO COLD CHISELLING

NO GROUTING IN

NO WAITING FOR T[illegible]MENT TO HARDEN

THEY GRIP BY EXPANSION

SAVE TIME with Rawlbolts. Grouted ragbolts will take 3 days to harden before the machine can be used. Use Rawlbolts and the machine can be in production in much less than 3 hours. It can be moved easily to a new position when necessary.

SAVE LABOUR with Rawlbolts. No laborious and time wasting cold chiselling with Rawlbolts. The holes are drilled with a Rawltool to the exact size, the Rawlbolts dropped in and after the machine has been positioned the bolts are tightened. The expansion of the segments locks the bolts in the holes.

RAWLPLUG

The world's largest manufacturers of fixing devices

Write now *for descriptive broadsheet of R 1480 which incorporates a half size Rawlbolt Reference Chart.*

THE RAWLPLUG CO. LTD · CROMWELL ROAD · LONDON S.W.7

B549B

TV packaging department at the company's Ilford factory. Mr. Hancock has evolved a new method of packaging TV and radio sets by which many of the expensive pieces of corrugated paper previously used can be eliminated. The new method has passed stringent tests by the company and has been approved by the Packaging and Allied Trades Research Association. It is the largest award so far made by Plessey for a suggestion put forward by an employee for consideration.

FIELDEN ELECTRONICS LIMITED have formed three new sales divisions; London, the North-East and the Midlands. **Mr. R. Speller,** after three years as company representative in London North, becomes manager of the London sales division. **Mr. F. G. Totty,** formerly Yorkshire representative, becomes North Eastern sales division manager, based on Stockton. **Mr. F. B. Price,** for many years Fielden representative in the Midlands assumes the management of the expanding Midlands sales division.

THE AMAR TOOL & GAUGE COMPANY Limited have appointed **Mr. J. Urpeth** as their Midlands representative.

Obituary

WE regret to record the death of **Mr. E. J. Waddington, A.C.A.,** director of Vickers Limited and of Vickers-Armstrongs Limited and, until his resignation owing to ill health, of many subsidiary companies of Vickers Limited. Mr. Waddington was 64 years of age.

WE regret to record the death of **Mr. Charles H. Clare,** managing director of Clare Collets Limited, Broadheath, Cheshire, at the age of 84. He was inventor of the Clare system of milling equipment and was founder of the company and technical director from its formation in 1919 until 1929, when he became managing director.

WE regret to record the death of **Mr. B. E. G. Forsling, M.I.Mech.E., M.I.Mar.E.,** at his home in Rugby. For the last eight years Mr. Forsling was manager of the BTH gas turbine engineering department at Rugby.

Addresses

GRIFFIN & GEORGE LIMITED, laboratory furnishers and manufacturers of scientific apparatus, are connected to the Telex System at their Alperton warehouse (Telex 21126) and Birmingham warehouse and works (Telex 33303). Their other provincial branches will be connected as soon as the installations are complete.

MESSRS. FREDERICK A. POWER & SONS (Box Strapping) Limited, Landor Street, Birmingham, 8, will in future be known as Power Strapping Systems Limited.

THE CITY AND GUILDS OF LONDON Institute has moved to new headquarters at 76 Portland Place, London W1. Telephone LANgham 3050, Telegrams Civic, Wesdo, London.

THE London offices of The British Thomson-Houston Company Limited, the British Thomson-Houston Export Company Limited, Metropolitan-Vickers Electrical Company Limited, Metropolitan-Vickers Export Company Limited, A.E.I.-Hotpoint Limited, and A.E.I.-Gala Limited are now at 33 Grosvenor Place, London SW1, telephone Belgravia 7011.

SUBSIDIARY companies of the former Siemens Brothers and Company Limited, in Australia, Canada, Central Africa and South Africa have changed their names. Siemens (Australia) Pty. Limited becomes Siemens Edison Swan (Australia) Pty. Limited, Siemens Brothers (Canada) Limited becomes Siemens Edison Swan (Canada) Limited, Siemens Brothers Central Africa (Pvt.) Limited becomes Siemens Edison Swan Central Africa (Pvt.) Limited, and Siemens Brothers British (Pty.) Limited becomes Siemens Edison Swan (Pty.) Limited.

CARLISLE branch office of British Insulated Callender's Cables Limited is now at Durranhill Industrial Estate, Harraby, Carlisle. Telephone as before, Carlisle 22221. The company's Nottingham branch office telephone number is now Nottingham 55932 (2 lines).

HEATHER FILTERS LIMITED—manufacturers of air filtration equipment and distributors for the Satomair and Humexair humidity control equipment—have moved their offices to 7, Kendall Place, Baker Street, London W1. Telephone HUNter 1801.

ANTI-DUST SERVICES LIMITED, of Dudley, Worcs., manufacturers of AD Taccy Rags, Taccy Pads and The Barrier Method of Dust Control have opened an office in London to serve South East England. The office is at 27 Eastern Avenue, Wanstead, E11, telephone number WANstead 3467 and is under the control of Mr. A. A. Evans, Sales Manager of the London and S.E. area.

MARTONAIR LIMITED, manufacturers of pneumatic equipment, announce the opening of two new branch offices: North-East, (representative Mr. C. P. White) Central Administration Building, Team Valley, Gateshead 11. The offices in Holyhead Road are replaced by a showroom, stockroom and office at 46, Great Hampton Street, Birmingham. Mr. R. A. Young remains office manager and the telephone number (NORthern 7273) is unchanged.

ARCON SAWTOOTH FOR LEEDS FACTORY.—A multi-span, steel-framed Arcon Sawtooth Roof structure, over 40,000 sq ft in area, and clad in brickwork, forms the main factory of the new Elland Road, Leeds, headquarters of Jackson Boilers, Ltd., opened last October. The roof was supplied by Taylor Woodrow (Building Exports) Ltd., London, marketing member of the Arcon Group

Numas

THE NATIONAL UNION OF MANUFACTURERS Advisory Service Limited—a non-profit making body formed to take over and expand the work of the Industrial Advisory Service, has published its report for the year ended December 1957. NUMAS offers an advisory service and practical assistance for the medium and smaller firms on problems of management and production organization. During that year 49 firms accepted paid surveys and 19 have had practical assistance in work study assignments; the staff of NUMAS has worked a total of 450 weeks on work study assignments.

New Blaw Knox Company

A NEW company—Blaw Knox Chemical Engineering Company Limited with registered offices at 90/94 Brompton Road, London, SW3, has been formed, and is owned jointly by Blaw Knox Limited of London and their associates, Blaw Knox Company of Pittsburgh, Pa.

A Decade of Activity

THE Institute of Industrial Supervisors last year celebrated its tenth anniversary, and the November issue of its journal "The Supervisor" carries a report of its work and achievements during the period. Recently the general secretary paid a visit to American industries and universities with a view to studying supervisory training in the U.S.A.

Sole Distributors

ALFRED HERBERT LIMITED have been appointed sole distributors in the British Isles for measuring and inspection equipment made by Censor of Liechtenstein. This equipment is complementary to that made by the Sigma Instrument Company Limited for which Alfred Herbert Limited are also sole distributors.

Admiralty Materials

THE materials sections of the Engineer-in-Chief's Department have now been amalgamated with other Admiralty material groups to form the new Ship Department.

Induction Heating - 2

The broad principles involved in the use of induction heating for melting and processing metals have already been dealt with in this series (Data Sheet No. 2). In order to make a critical examination of its possibilities, however, the potential user should be aware of certain technical factors which must influence his decisions.

Induction heating, of course, demands the use of alternating current which is available from the public supply at a frequency of 50 cycles per second. Higher frequencies, however, are desirable for certain applications and can be obtained by means of the appropriate conversion equipment. Frequencies can therefore be considered in three categories:

Mains Frequency
(direct from mains)—50 c.p.s.

Medium Frequency
(machine generator)—50-10,000 c.p.s.

High Frequency
(electronic generator)—up to about 2,000,000 c.p.s.

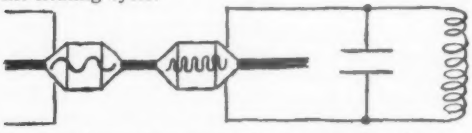
Mains Frequency

This needs no conversion equipment; it is particularly suitable for melting large pieces of scrap and, owing to the vigorous stirring forces produced, is excellent for alloy making. It has the merit of low initial cost compared with the high frequency method of melting, but is not so suitable for the production of high grade steel. Mains frequency induction heating is also useful for stress-relieving of welds in pipes and vessels, heating of chemical vessels, pipelines, injection moulding machines and press platens.

A typical example of the use of mains frequency is the coreless induction melting furnace which can be connected direct to the public 3-phase supply. Such a furnace rated at 120 kW, with a holding capacity of 2,240 lb., will give a throughput of 5,000 lb. per hour of hot cupola metal superheated from 1,350°C to 1,450°C.

Medium Frequency

Motor generators ranging from 10 kW to 1,500 kW or more at frequencies up to about 10,000 c.p.s. are widely used for heating for forging, melting from 100 lb. to 10 tons, hardening, annealing, etc. A bank of capacitors maintains a high power factor during the heating cycle.



Another form of generator for frequencies of 1 to 2 kc.p.s. and powers around 250 kW, useful for forge heating and melting high temperature aircraft alloys, is a 6-anode steel tank mercury arc inverter.

High Frequency

Metal hardening and metallurgical processing are best handled by high frequency induction (up to about 2,000,000 c.p.s.), particularly when a very thin case is required or when the section of the workpiece is too small to heat satisfactorily at medium frequency. These high frequencies are produced either by an electronic h.f. generator or a mercury-gap h.f. generator; high frequency induction can deal efficiently with such jobs as hardening lawnmower cylinders and cutters, bars and axle shafts.

The choice of frequency depends upon the metallurgical requirements and the size of the component to be treated. The following table gives the practical relationship between size and frequency, and may be used as a guide to the choice of generator, subject to metallurgical considerations.

Optimum Value

FREQUENCY C.P.S.	3,000	10,000	500,000	2,000,000
MIN. DEPTH OF HARDNESS POSSIBLE	.060 in.	.040 in.	.020 in.	.010 in.

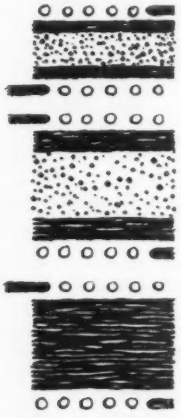
Practical Values

MIN. DEPTH HARDNESS EXPECTED	.150-.200 in.	.100-.150 in.	.030-.050 in.	.015-.030 in.
MIN. DIA. SURFACE HARDENING THIN CASE	2" & over	1" to 3"	½" to 2"	¼" to ½"
MIN. DIA. SURFACE HARDENING DEEP CASE	2" & over	2" & over	1" & over	not suitable
MIN. DIA. THROUGH HARDENING	1" & over	½" to 2"	¼" to ¾"	not suitable

These are of course very approximate since they also depend on metallurgical considerations.

Power required for H.F. Induction Hardening

The high frequency power required per sq. in. of hardened surface depends upon the amount of metal behind the surface. Higher powers and shorter heating cycles are necessary for thin cases and when the thickness of metal behind the surface is small.


0.03" to 0.04" requires 1 sec. or less at 10 kW or more per sq. in.
0.1" to 0.2" with a large mass of metal behind the surface, requires 10-60 secs. at 2 kW per sq. in.
Through hardening requires 10-12 kWh per lb.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association. Excellent reference books (8/6, or 9/- post free) are available on electricity and productivity—"Induction & Dielectric Heating" is an example.

E.D.A. also have available on free loan a series of films on the industrial use of electricity. Ask for a catalogue.

Issued by the Electrical Development Association, 2 Savoy Hill, London, W.C.2 6515

Contracts and Work in Progress

WILD-BARFIELD ELECTRIC FURNACES Limited.—Order for a special 50 lb induction vacuum furnace from Bristol Aero-Engines Limited.

The three gas carburizing furnaces to supplement those already supplied and a large shaker hearth equipment recently ordered by the heat treatment department of Van Doorne's Automobielfabriek N.V. have now been delivered to the DAF car works at Eindhoven.

GENERAL ELECTRIC COMPANY LIMITED.—Order from the Quarry of Adelaide Cement Company Limited of South Australia for a Dixie non-clog hammermill, 72 in. dia 60 in. wide weighing 70 tons. This swing hammermill is now under construction at Erith and is the largest ever to be designed and built in Britain.

HEENAN & FROUDE LIMITED.—Order for a Heenan-Dynamatic (eddy-current) dynamometer from J. Stone & Company (Deptford) Limited.

WESTINGHOUSE BRAKE & SIGNAL COMPANY Limited.—First part of a large order covering the supply of vehicle battery charging equipment in the new assembly buildings for the Ford Motor Company at Dagenham awarded to the Rectifier Division. This division has also secured the order for the supply of vehicle battery charging equipment through Murphy Electric Company for modernization work being carried out by Cork Corporation.

Order from the National Coal Board Durham Division for underground locomotive signalling equipment at Murton/Eppleton—the largest single underground locomotive signalling system ever to be adapted for British mines.

ASSOCIATED ELECTRICAL INDUSTRIES Limited, Heavy Plant Division, Rugby.—Order for large electric drives for rolling mills from Northern Aluminium Company Limited.

—Contracts from The National Coal Board, West Midlands Division, placed with the Heavy Plant Division, Rugby, for four winder equipments valued at almost £700,000.

MARCONI INSTRUMENTS LIMITED.—Recent orders totalling approximately £40,000 for Type TF 1555B X-ray equipment from British firms including Rolls Royce Limited, the Redheugh Iron and Steel Company (1936) Limited and Vickers-Armstrong (Engineers) Limited. Two additional equipments recently delivered to the Ministry of Supply and U.K.A.E.A.

QUASI-ARC LIMITED.—Recent orders from British Shipyards for automatic welding gantries include those from Vickers-Armstrongs Limited and Joseph L. Thompson & Sons Limited. The gantry was originally developed in close collaboration with Harland and Wolf Limited.

PYE LIMITED.—Contract for the supply of Television equipment to the first Italian nuclear power station awarded by the Nuclear Power Plant Company.

THE INCANDESCENT HEAT COMPANY Limited, Smethwick.—Contract worth more than £500,000 for a large coil annealing installation at the new steelworks of the Sociedad Mixta Siderurgia Argentina (SOMISA).

AMONGST British Railways (Scottish Region) contracts recently placed by the British Transport Commission are: Paterson, Hughes Company Limited, Glasgow—25 ton electric travelling goliath crane, Bridgeton Goods Station. Whittaker Hall & Co. (1929) Limited, Manchester.—Rotary air compressor, St. Rollox Works, Glasgow. The Consolidated Pneumatic Tool Company Limited.—Hicycle tools and frequency changers, St. Rollox Works. Alex Findlay & Co. Limited, Motherwell—Steelwork in crane gantry, portal frames and tup tester, Motherwell permanent way depot. The Brightside Heating and Engineering Company Limited, Edinburgh.—Heating installation, Townhill Junction new wagon repair depot, Dunfermline. P. & W. Anderson, (Glasgow) Limited.—Extension to chain repair shop, Cowlairs Works, Glasgow. Edward Curran Engineering Limited, Cardiff.—Wheel cleaning machine, Cowlairs Works, Glasgow. Thomas Henderson and Son (Glasgow) Limited—Track sectioning cabin, Dalmuir Park, Glasgow. Standard Telephones and Cables Limited, London.—Supply and installation of control telephone equipment, Airdrie/Helensburgh line and branches. Train describer apparatus, Glasgow Central resignalling scheme. James Scott & Company (Electrical Engineers) Limited, Glasgow—Electric power and lighting scheme for diesel maintenance facilities, Dundee West motive power depot. G. Reid & Son Limited, Catrine.—Erection of electric control centre, Cathcart.

New Solartron Agreement

SELLING and manufacturing licensing agreements for the Kintel range of electronic products of the Cohu Electronics, Inc., of San Diego, California, U.S.A. have now been concluded by the Solartron Electronic Group, Limited, Thames Ditton, Surrey, England.

Hollerith East Africa Company

THE recently established East African company of The British Tabulating Machine Company Limited.—Hollerith East Africa) Limited—is the latest of the six overseas subsidiary companies set up by the parent concern. The new subsidiary has taken over from Hollerith Machines (South Africa) (Proprietary) Limited existing business in Kenya, Uganda, Tanganyika, and Zanzibar.

Cutting-off Machines

THE Haesler Sales Division of Adam Engineering Company Limited, 4 Grange Street, St. Albans, Herts, have been given the exclusive agency for Great Britain of the Devaud cutting-off machines, manufactured by Messrs. A. Devaud, Tavannes, Switzerland.

Tungsten Carbide Exports

IN order to expand its tungsten carbides exports to South America, Wickman Limited have acquired a majority holding in Brasmac Industria e Comercio S/A, Sao Paulo, Brazil.

Sales Agency

RUSSELL NEWBERY & CO. LIMITED, diesel engine manufacturers of Dagenham, Essex, have appointed Raw and Partner, Greendale Road, Woolton, Liverpool, as their sales agents for Lancashire and Cheshire.

Metal Industries Acquire Towler Bros.

THE whole of the share capital of the privately-owned Towler Brothers (Patents) Limited, together with its subsidiary Electraulic Presses Limited, has been acquired by Metal Industries Limited. The amount paid is £800,000.

Tilghman-Bohler

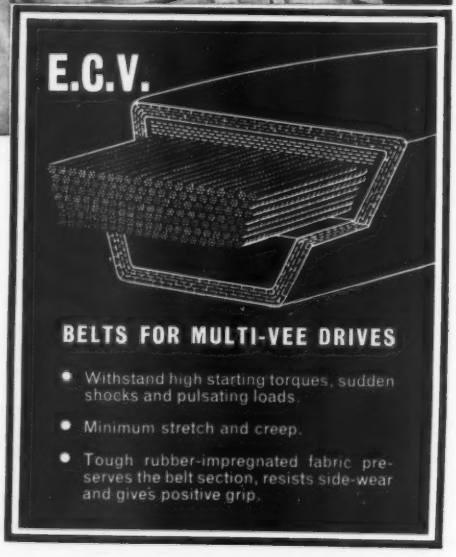
THE British Isles selling rights of pneumatic tools manufactured by the Austrian firm of Gebr. Bohler & Co., Vienna, have been granted to Tilghman's Limited of Broadheath, Altrincham, Cheshire. The latter company have established a pneumatic tools division under Mr. F. Marsh at 1 Chester Street, London SW1.

Tyre Factory for Turkey

THE tyre factory which, by agreement with Federal Turk Kamyonlari A.S. of Ankara, the Dunlop Rubber Company Limited is to establish in Turkey, will be designed by Dunlop Advisory Service Limited. The Dunlop Company will acquire a financial interest in the project.

Drill Guarantee

A SIX months unconditional guarantee has been announced by S. N. Bridges & Company Limited for their electric drill fitted with Neonic eye safety device.


E.C.V.
BELTS FOR MULTI-VEE DRIVES
• Withstand high starting torques, sudden shocks and pulsating loads.
• Minimum stretch and creep.
• Tough rubber-impregnated fabric preserves the belt section, resists side-wear and gives positive grip.

Greater V-Belt reliability means more productivity

YOU CAN'T RISK costly shutdowns on full-scale production jobs – that's why Goodyear belts are the wisest choice for Multi-Vee drives. They can be fitted and forgotten – there's no better testimony to their trouble-free operation! There's a range of these 'job-designed' Goodyear V-Belts to give longer service and more efficient transmission on every type of drive.

The Goodyear Technical Man will gladly advise on the right belt for any job.

GOODYEAR

INDUSTRIAL RUBBER PRODUCTS

CONVEYOR BELTING · V-BELTS · TRANSMISSION BELTING · HOSE

Buck & Hickman General Catalogue, 1958

This veritable encylopædia of small tools and supplies for all mechanical trades needs little introduction to the engineer. The present edition of some 1275 pages is strictly in conformity with previous editions, every item as far as possible being illustrated and priced. Whilst the prices quoted are obviously subject to frequent fluctuations they still represent a valuable feature and Buck & Hickman Limited, 2 Whitechapel Road, London E1, are to be complimented on retaining the practice. Formulae and tables covering English and Metric weights and measures, screw threads, pipe flanges, tubing and material gauges are included.

Guide to Molybdenized Lubricants

A revised publication, detailing the vast range of applications for molybdenized lubricants in industry, has been published by Rocol Limited, Ibex House, Minories, London EC3. An introduction explains the properties of molybdenum disulphide, the full range of lubricants, greases, oils are described and the guide concludes with an extensive list of applications where Rocol lubricants have been successfully applied.

Oil Seals, Packings and Rubber Products

Some indication of the wide variety of products made by George Angus and Company Limited, Angus House, 152-158 Westgate Road, Newcastle upon Tyne 1, is given in a new pamphlet. They include hydraulic packings, oil seals, transmission and conveyor belts, machine cut gears and industrial protective clothing.

Turbine Driven Feed Pumps

The outstanding features of the Weir SD and QB are described and illustrated in two companion leaflets issued by G. & J. Weir Limited, Cathcart, Glasgow S4.

Non-ferrous Pressings

The activities of Brass & Alloy Pressings (Deritend) Limited, Liverpool Street, Birmingham 9, are briefly summarized in a booklet. They include hot brass and aluminium bronze pressings from 0·1 oz up to 25 lb and light alloy pressings up to 7 lb.

Speed Reduction Gear Catalogue

The catalogue of Heliocentric speed reducing gears issued by Sanderson Brothers and Newbould Limited, P.O. Box No. 6, Newhall Road, Sheffield 9, has now been fully revised. These compact co-axial machines are made in the following stages and ratios: single stage, ratios 20:1 to 80:1, double stage, ratios 400:1 to 6400:1 and triple stage, ratios 8000:1 to 512,000:1.

Typical applications are illustrated and an appendix is included giving tables of dimensions and torques of all types.

Plate Edge Preparation

The Oxyplane plate edge preparation machine is described in a brochure now available from British Oxygen Gases Limited, Spencer House, St. James's Place, London SW1.

The machine consists of two parallel tracks carrying three mobile cross beams on which cutting units are mounted. The centre mobile cross beam is motorized and the end beams are positioned by hand. The track length of the standard machine is 53 ft 3 in., and this enables plates of up to 40 ft × 10 ft to be cut. The main tracks are sectional, however, and can be arranged to cover any required length of cut. A machine which is capable of preparing plates of up to 12 ft in width is also available.

Forging Difficult Materials

One of the first companies to forge titanium when this metal was newly produced in this country was Daniel Doncaster & Sons Limited, of Sheffield, who, with their extensive background of experience in forging and drop forging the more highly developed alloy steels, were well equipped to undertake the intricate procedures and special skills needed for the manipulation of such difficult materials.

Trade Literature

To assist firms now considering the application of titanium, Nimonic, zirconium, aluminium bronze, heat-resisting alloys, etc. Doncasters have now issued a well-illustrated brochure which outlines their experience and resources in the design and production of components.

Another section of the book describes the activities in production of precision forged blades for compressor blades and turbine blades for gas and high temperature steam turbines, and concludes with short descriptions of the facilities for producing hardened forged steel rolls for cold rolling—one of the most exacting of metallurgical achievements, and of powder metallurgy.

German Industrial Standards

The German Standards Committee (Deutscher Normenausschu) has established a special department to prepare translations of German industrial standards in English, Spanish and French. So far, 450 English translations have been made.

Lists of the translations available may be obtained free of charge from the Beuth-Vertrieb GmbH, Berlin W 15, Uhlandstr. 175.

Roller Bearing Catalogue

In the new Pollard Max-Load high capacity roller bearings catalogue, Ref. No. MAX.10/58 the complete range of their Max-Load bearings are tabulated and all relevant dimensions, weights, working load ratings and the basic reference numbers of American-made bearings to which Pollard bearings correspond are given. Also included are bearing selection details, conversion graphs, details of bearing location. alignment, retention and seals. The catalogue is available from Pollard Bearings Limited, Ferrybridge, Knottingley, Yorks.

Slat Band Chains

A leaflet, Ref. No. 320/49 describing the Coventry slat band chain and wheels has been issued by Renold Chains Limited, Renold House, Wythenshawe, Manchester. The chains comprising two components, the slat plates and the pins are ideal for conveying applications in industry and are supplied in stainless material or case hardened mild steel. Full dimensional details are given.

Silicone Rubbers

A new booklet prepared by the Nobel Division of Imperial Chemical Industries Limited, Imperial Chemical House, Millbank, London, SW1 summarizes the grades, properties and applications of silicone rubbers in industry.

Controlled Atmospheres for Metallurgical Processes

A reprint of an article of the above title which appeared in Metal Treatment and Drop Forging, June-July 1958 has been prepared by The Incandescent Heat Company Limited, Cornwall Road, Smethwick, Birmingham. Heat treatment processes which are best performed in neutral or active reducing atmospheres are described, and the underlying chemical reactions discussed. In the second part present day processes and plant for generating special atmospheres are surveyed.

Zirconium and its Alloys

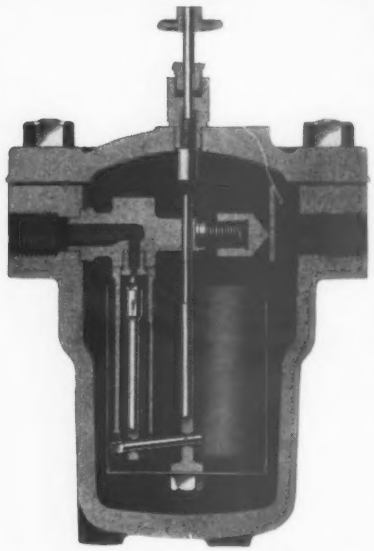
An excellent information sheet, reference No. M.840 has been issued by William Jessop & Sons Limited, Sheffield on the properties of zirconium and its alloys. Sections describe the method of manufacture, physical and mechanical properties, thermal neutron capture cross section and corrosion and scaling resistance.

Masters of Steel

Few who have witnessed steel furnace tapping or "teeming" the moulds, in fact the everyday life of the large steel foundry, will deny that it has some magical appeal and fascination. To conjure up this scene in brochure form is not easy but a very creditable attempt has been made by F. M. Lloyd & Co. Limited, P.O. Box No. 5, James Bridge Steel Works, Wednesbury, Staffs, who have published a booklet entitled "Masters of Steel". Illustrated in colour and black and white it gives a factual picture of how steel castings are made and are used in engineering generally.

"The Lancaster"

REG? TRADE MARK



COMPACT BUCKET TYPE STEAM TRAP

Specially designed to go in a small space yet to give a copious discharge. Will lift its discharge water 2 ft. for each 1 lb. pressure of steam. AUTOMATIC "AIR-VALVE" eliminates "AIR-LOCK." Fitted with NICKEL VALVE and SEAT.

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sizes up to 2" bore

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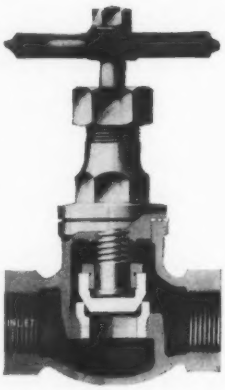

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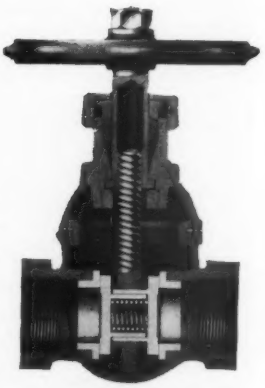
Sturdy general-purpose valves for isolating or regulating purposes. Screwed or flanged connections available.



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Reliable general-purpose valves for duties where the flow is in either direction. Screwed or flanged connections available.

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Robust quick-opening valves on parallel-slide principle. Easy to operate, suitable for many duties including process steam control, compressed air, thick heavy liquids, etc. With screwed connections.

All the above valves are for pressures up to 250 lb/sq. in. (steam) or 350 lb/sq. in. (cold water, air, oil, etc.)

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HV 113

Brandon (Co. Durham). Margy Belts Limited, manufacturers of umbrellas, handbags, etc., Langley Moor, are seeking permission to convert an old store in High Street into a factory to employ about 80 women and girls.

Carlisle. Lawson and Son, joiners and undertakers, Port Road, are to erect a new machine shop to plans by G. W. Danson, 54 Lowther Street.

Cleator (Cumberland). Cumberland Paper Company. Tenders are now being received for factory additions. The work is being carried out under the authority of the West Cumberland Industrial Development Company, 30 Roper Street, Whitehaven. The architects are R. Ward and Partners, 29 Chesham Place, Belgrave Square, London, SW1.

Consett. Consett Iron Company Limited, are to build amenity block and sub-station at the new foundry, and extend the loading bay at the billet mill and have prepared their own plans.

The National Coal Board, Springfield, Shotley Bridge, are to extend the coal washery at Crookhall Colliery.

Gateshead. J. Rowell and Sons, brewers. Plans for reconstructing the bonded warehouses are being prepared by Cackett, Burns, Dick and McKellar, 21 Ellison Place, Newcastle upon Tyne.

Hebburn-on-Tyne. Wailes Dove Bitumastic Company Limited. Office additions are proposed in Hedgeley Road. The architects are Gray and Partner, Portland Terrace, Newcastle upon Tyne.

Middlesbrough. Neshams Garages Limited. Plans for rebuilding workshop in Grange Road have been prepared by Garbutt, Archibald and Archibald, 23 Albert Road, Middlesbrough.

Winterschladen and Company. A bottling store is to be built to plans by T. A. Crawford, 80 Borough Road, Middlesbrough.

Newcastle upon Tyne. Gallaher Limited, Granite House, Cannon Street, London EC4 are to erect a distribution warehouse and ancillary offices at Welbeck Road to plans by their staff architect, G. A. Henry.

White and Company (Newcastle) Limited, are to provide a quilt factory at Killingworth Place to plans by M. Gatoff, 26 Mosley Street, Newcastle.

Novo-Enterprises, Limited are to erect a three-storey industrial building in Blandford Street to plans by H. Gatoff, 51 Grainger Street.

Tyne-Taxis Limited, are to build a garage in Dinsdale Place. The architect is C. Solomon, 30 St. Mary's Place.

George Angus and Company Limited, are to reconstruct part of their factory in Clayton Street to plans by C. S. Errington, 46 Grainger Street.

South Shields. Radiant Fireplaces, Limited, Western Road, Jarrow are to erect a factory on the Simonside Industrial Estate to plans by Sherbourn Engineering Limited, Birmingham, 27.

Sunderland. Allinson and Son, corn merchants, Whitburn Street Mill, are planning the erection of a new mill of about 7,000 sq ft in Henry Street East and the scheme is being discussed with the planning authorities. The architect is R. A. Yendall, 12 Georgian Court, Sunderland.

Bergson and Company Limited. Factory extension of 3,000 sq ft proposed at Bonnersfield. The builders are Sloan and Earnshaw, 60 Dundas Street.

West Hartlepool. William Gray & Co. Limited, are to construct a new No. 2 berth at their Central Shipyard.

Whitehaven. West Cumberland Silk Mills, Limited. The contract for factory additions has been let to Border Engineering Contractors, Limited, Queen Street, Whitehaven. The architects are R. Ward and Partners, 29 Chesham Place, Belgrave Square, London, SW1.

Birkenhead. Fusion Welding & Construction Company, 81 Vittoria Street, are to build a new factory at Brook Street and Vine Street.

Birmingham. Phosphor Bronze Company Limited, Bradford Street, are to make extensions to their factory in Rae Street and High Street, Deritend.

Alfred Case & Co. Limited, Great Tindal Street, are to spend £100,000 on extensions to their works over the next five years.

New Factories

Bolton. Bolton Railway & Ironworks Company Limited, Manchester Road. Extensions to works.

Joseph Whitehouse (Bolton and Bury) Limited, Rosalina Street. Works extensions.

Bristol. British Process Mounting Company Limited, 58 Granville Street. A new factory is to be built at Brislington.

London Electric Company and Smiths Limited, 10 Narrow Quay. A new factory is to be erected in King Street.

British Insulated Callenders Cables Limited, 7–9 Barton Street. Works extensions. Architects, Burrough & Hannam, 17 Orchard Street, Bristol.

Burnley. Burnley Aircraft Products Limited, Britannia Mill, Ruskin Street, are to make extensions to their works.

Buxton. Brake Linings Limited. The factory in Bridge Street is to be extended.

Chesterfield. Park Foundry Company (Chesterfield) Limited, Park Road, are to make extensions to their works.

British Electrical Repairs Limited, Lordsmill Street. Extensions to works.

Croydon. H. Bradley Limited, 34 Church Road, Upper Norwood, London SE19. Extensions are to be made to Carberry Works, Carberry Road.

Brooks Ventilation Units Limited, Trafalgar House, 9 Great Newport Street, London WC2. A new factory is to be erected in Gladstone Road.

Derby. The Spiral Tube & Components Company Limited, Honeypot Lane, Stanmore, are to erect a new factory.

Doncaster. Pilkington Bros. Limited, Kirk Sandall, are to make extensions to their works.

Dudley. B.A.L. Limited, Oakeywell Street, are to extend their works.

Edmonton. Cut Metals Limited, 67 Ranelagh Road, London N17. A new factory is to be erected on the industrial estate at Montagu South.

Enfield. Acme Showcard & Sign Company Limited, are to extend their works.

Regent Shop Fitters Limited. A new factory is to be erected at Alexandra Road.

Hemel Hempstead. Gates Electronics Limited are to erect a new factory. Bernard Sunley & Sons Limited, 25 Berkeley Square, London W1 have received the contract.

High Wycombe. Osters & Fleming Limited. Plans have been approved for the erection of a new factory at Coronation Road.

Nicholls & Janes Limited, Queens Road, are to extend their factory.

Hull. Hull Premier Printing Company Limited, Cumberland Street, are to extend their works.

Keighley. J. Lund Limited. Plans have been passed for extension to Eastburn Foundry, Cross Hills.

London. M. Saper Limited, Argall Avenue, Lea Bridge Factory Estate. Plans have been approved for extensions to their factory.

Bradley Cook & Co. Limited. A new factory is to be built in Coronation Road, London NW10.

Loughborough. W. Cotton Limited. Extensions are to be made to the factory in Bottleacre Lane.

Maidstone. A. E. Reed & Co. Limited, are to erect a new factory in Church Street, Tovil.

Nuneaton. Freeman & Proctor Limited, King Edward Road. The architects for extensions to the factory at Anker Street, are H. N. Jepson & Partners, Midland Bank Chambers, Newdigate Place.

Peterborough. British Horticultural Company Limited. Extensions are to be made to the factory at Lincoln Road, Walton.

Plasticast Developments Limited, are to extend their works in Lincoln Road, Werrington.

Rotherham. Steel Peech & Tozer Limited, The Ickles. A new roll grinding and fitting shop is to be built at the works.

Southport. Arnold Kinnings & Sons, 168a Norwood Road. The architects for the new factory at Meols Cop Road, are Huckle & Durkin, 268 Sefton House, Exchange Street West, Liverpool.

St. Leonards. Elva Engineering Company Limited, Sedlescombe Road North. Permission has been granted for the erection of a new sports racing car factory.

Stretford. Donald MacDonald Limited, Trafford Bar, Manchester 16. Extensions to factory.

Tunbridge Wells. Tempo Laboratories Limited, 80 St. Johns Road, have applied for permission to erect a new factory at Lamberts Road, North Farm Industrial Estate.

Watford. J. H. Jones & Sons (Beverages) Limited, 179b Queens Road, are considering the erection of a new factory at Holywell Industrial Estate.

Welshpool. Powysland Newspapers Limited, Shrewsbury are to erect a new printing works.

West Bromwich. Ready Bros (West Bromwich) Limited, Izans Road, are to erect a new factory at Brandon Way.

Johnsons Iron & Steel Company Limited, Church Lane. Factory extensions.

Wimborne. The Tungsten Manufacturing Company Limited, 8 Heddon Street, London W1, are considering the erection of a new factory.

Montrose. Glaxo Laboratories Limited are extending their Cobden Street premises. The first floor of the new block includes a store, engineering shop and other works. The upper floor carries drawing offices, draughting and other facilities.

Rutherglen. A hosiery factory is to be built at 139 King Street for Mr. James Wilson of Rutherglen. Plans have been approved by the Dean of Guild Court

CLASSIFIED ADVERTISEMENTS

Situations Vacant

ASSISTANT DESIGN ENGINEERS

are required by the Atomic Energy Authority in its design offices at Risley, Warrington, to undertake individual design work of a high standard or to lead small teams of draughtsmen, and to give assistance at sites during construction and commissioning.

NUCLEAR CHEMICAL PLANTS AND FUEL ELEMENT PLANT—

design and specification of both conventional and radioactive chemical plants and laboratories involving the use of chemical engineering techniques; design of equipment for casting, heat treatment, remote handling, welding and automatic control problems requiring special materials. (Ref. 2803/J.44).

MECHANICAL POWER SERVICES—

design and specification of boiler and compressor plant and associated pipework; installation of diesel engines. (Ref. 2804/J.44).

REACTOR DESIGN—

design of nuclear reactors involving power plant layout, boilers and heat exchangers, steam and feed water plant, mechanical handling, instrumentation, centrifugal or axial fans, variable speed drives, centrifugal pumps, pressure vessels, heating and ventilation, machine tool and general machine design. (Ref. 2805/J.44).

ELECTRICAL ENGINEERING—

layout of E.H.T. systems; specification of switchgear and cabling, and large and small rotating machines; H.T. and L.T. factory distribution. (Ref. 2806/J.44).

INSTRUMENTS—

design and application of measurement and control systems in the field of industrial instrumentation as applied to extensive chemical plants and unique processes for the treatment of radioactive materials, and to prototype and testing reactors. (Ref. 2807/J.44).

Salary for these posts between

£880 and £1270

Applicants must have served a recognised engineering apprenticeship and possess at least an H.N.C. or equivalent in an appropriate subject. Comparable training in lieu of apprenticeship will be accepted for Instruments posts. Good design experience in one or more of the fields outlined is essential, whilst graduate membership of a senior engineering institution would be an advantage.

DRAUGHTSMEN

are also required on the above projects, which provide opportunities to gain experience and promotion on interesting and vital work in connection with the development of nuclear energy. (Ref. 2808/J.44).

Salary for these posts between

£555 (at age 21) and £865

Applicants must possess an O.N.C. or equivalent in an appropriate subject and have at least three years workshop experience. Drawing office experience in one or more of the fields outlined is desirable.

Contributory Superannuation. Staff housing scheme.

Send postcard for application form quoting appropriate reference to

Chief Recruitment Officer,

UNITED KINGDOM ATOMIC ENERGY AUTHORITY,

INDUSTRIAL GROUP HEADQUARTERS,

RISLEY, WARRINGTON, LANCASHIRE.

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10FT. × ¼" CRAIG & DONALD PRESS BRAKE for sale. All Steel construction. Model 400/10. Motorised with 50 hp motor suitable for 400/3/50. F. J. Edwards Ltd., 359, Euston Road, London N.W.1. Euston 4681, or 41 Water Street, Birmingham 3. Central 7606.

PLASTIC Patterns, and Coreboxes reinforced with Fibre-glass, strong, durable light and accurate. Made to specification, or from customer's wood patterns. Robert R. Shaw, Falkirk Pattern Works, Larbert, Scotland. Phone Larbert 300.

FOR SALE 10 Heat Exchangers, Makers Holden & Brooke, horizontal type. Overall dimensions 12" 6′ × 4′ dia., Shell and Covers welded construction. Capacity 810 galls per minute. Water from 110°F to 90°F, suitable for working pressure of 100 lb per sq in. Each contains nest of 1280 Steel Tubes 8′ long ¾" o.d. and 16 swg. Recently left off working. Apply: Thos. Jenkins & Son Ltd. Exchange Buildings, Port Talbot.

"FRIGIDAIRE" Low Temperature Refrigerators. 49 in.w × 28 in.d × 34 in.h ext. Ex Large National User, suitable A.C. or D.C. Deep Freezing, Storage of Ice Cream, Frozen Foods, etc. Price £40.0.0 each. Domestic Refrigerators, Service Cabinets and Cold Rooms also available. A.R.C., 134 Great Portland Street, London W1. MUSeum 4480.

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Patents for Sale or License

THE proprietors of Patent No. 677090 for "Improvements in or relating to Drive Mechanisms for Typewriter Ribbons" desire/s to secure commercial exploitation by License or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28 Southampton Buildings, Chancery Lane, London W.C.2.

THE proprietor of British Patent No. 657949, entitled "Flareless Tube Coupling", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

PATENT No. 799076 "Unique Intruder Alarm" for sale or license. Warner, 62, Howard Road, Leicester.

THE proprietor of British Patent No. 711112, entitled "Improvements relating to the condition of the exhaust gases of internal combustion engines" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to